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Modern Problems in Illumination.

[Fifth and Final Lecture, delivered by MR. J. S. DOW, at the Polytechnic, Regent street, London, Friday, February 21st, 1913.]

The tendency nowaday is to sepcify the actual illumination required on the table or desk where work is done. For example, in the series of lighting tests carried out by Mr. D. R. Wilson, of the Home Office in England, data were invariably expressed in this form, and it is possible that in the future a regular standard of illumination in foot-candles for various classes of work will be established. It is, therefore, essential for the contractor to know how to scheme out a system of lighting in such way as to provide a certain illumination on the working plane.

The problem of determining the illumination from a lamp, hung at a good height over a table or desk or counter, is a comparatively simple one. One has only to know the polar curve of light distribution from the lamp to determine the candle power downwards and then to divide this by the square of the distance. But the determination of the horizontal illumination some distance away from the lamp is somewhat more complicated. One can do this by using the formula:

$$\text{Illumination} = \frac{I\alpha}{h^2 + d^2} \cdot \cos\alpha = \frac{I\alpha}{h^2} \cdot \cos^3\alpha$$

where $I\alpha$ = the intensity at an angle with the vertical.
h = the height of the lamp.
d = the distance from a point immediately under the lamp of the spot under consideration.

Naturally it is essential to know the polar curve from the lamp in order to work out this data, and modern firms interested in gas lighting are beginning to supply information of this kind. For example, quite a number of firms showed apparatus for obtaining the polar curve, and gave the results obtained there from the Optical Convention held in London last June.

It is not difficult to arrange the distance apart of two lamps so that the illumination between them does not fall below a certain value. One can go further still and scheme out reflectors in such a way that, when the units are placed at a distance apart equal to a certain multiple of their height, one gets even illumination.

"Extensive," "intensive" and "focussing" types of reflectors, and appropriate spacing rules for use with them, have been worked out for electric lighting, but less frequently for gas lighting. However, information of this kind will no doubt be more readily available for gas in future.

Turning to general problems in lighting Mr. Dow described the illumination of a certain drill hall, as showing the variety of points to be considered in arranging a scheme of illumination.

In connection with private houses a fair amount of latitude would be allowed. Tastes differed as to how the lights should be arranged, and the chief points of common agreement were the avoidance of glare and the provision of enough illumination to read by.

For the sake of the children it was particularly important that there should be good reading-illumination in the room where their lessons were done. In the same way kitchen lighting was often neglected, and there was no doubt that this had a prejudicial effect on the results of cooking. Mr. Dow also made special reference to the switching arrangements, showing how important it was to subdivide the lighting so that only those lamps need be turned on which were actually required. Ingenious switches for electric lighting were available, by the aid of which lights could be turned on-and-off from two places independently, and in gas lighting fuller use might often be made of the various electric and pneumatic systems of control. Mr. Dow referred to the problems met with in lighting hotels, hospitals and shops. Three foot candles were usually considered enough for reading, and ½ to 1-foot candle was enough to enable people to see their way about; *e. g.*, for general illumination in corridors; but in the show window, 10 to 30-foot candles might be provided for spectacular lighting. It would be noted that there were two distinct classes of shop lighting; (a), those shops in which the window was regarded as a catalogue which gave the passers-by an idea of all the objects that could be bought at that establishment; and (b), those in which the window was used as an artistic attracting device only, a few special goods being displayed. In the latter class, illumination by concealed lamps, on the same principle as the stage, was becoming universal. In some of the shops in Berlin a rotating window was provided, enabling one window to be dressed while another was being shown to the public. Naturally it is much easier to light artistically a window that is not overcrowded.

In the same way a distinction should be drawn between the restaurant, where people only come in for a short time to get a hasty meal, and those who laid themselves out to provide a table d'hôte. In the latter case subdued, cosy lighting in small alcoves would be demanded; while in the former class a general, brilliant illumination over the entire shop was needed.

Naturally the speed with which customers were served depended on the provision of a good illumination. In the same way in shops it was invariably found that the attendance was faulty if there was not enough light on the goods and counters.

Referring to lighting in factories, Mr. Dow laid stress on the fact that good lighting made the quality and output of the work better, as well as being essential to the interests of the workers. He detailed the steps taken by the Home Office in Great Britain, and the French Government, both of which had appointed special committees on industrial illumination. These would have most important and valuable results. In a factory representing a specific problem one had to understand the kind of work carried on in order to light the place in a really scientific manner.

Schools and libraries had been dealt with briefly in the previous lectures. The lighting of railways was an interesting and important problem since the lighting bill even of a small railway might easily amount to several hundred thousand dollars per annum. The standard of illumination was very much higher than it was a few years ago, and the underground railways in London had shown themselves particularly enterprising in providing illuminated signs which gave information at a glance and prevented much questioning of harassed employees. At a recent discussion in the Illuminating Engineering Society, it was suggested that a minimum value of ½-foot candle should be provided on main railway platforms.

Street lighting was a most difficult problem which had not yet been solved to any appreciable extent. In the early days, when only oil lighting was available, disorder had been rife in the street, but this had disappeared as the illumination improved. Light, in short, was a great friend of the police. But nowaday the lighting had passed this stage and its main function was to facilitate modern, fast-moving traffic. The recent increase in street accidents have given grave concern in England, and this seemed to be partially due to the abuse of modern bright illuminants. General illumination in the streets had increased very largely, but there was a marked tendency to glare. The whole question had not been thoroughly studied yet, but it was of interest to note that a joint committee, composed of the Illuminating Engineering Society, the Institutions of Electrical and Gas Engineers, and the Institution of County and Municipal Engineers, had been engaged in the project of drafting a Standard Specification on Street Lighting. This was to be discussed in a paper before the Illuminating Engineering Society, April 15th. As illustrating the difference in illumination provided for various classes of roads, Mr. Dow gave the following figures presented by Mr. Haydn T. Harrison:

Country roads	0.005	foot candles.
Side streets	0.01	"
Main streets	0.05	"
Main thoroughfares	0.1	"

The method of suspending lamps over the center of the street was becoming common in England and on the Continent, and quite a number of streets in the City of London were lighted by gas and electric lamps arranged in that way. But the question of the comparative merits of this system and that of "staggering" lamps on either side of the roadway had not been thoroughly threshed out. All these were questions that would solve themselves in the course of the next few years.

[Official Report.—Continued from Page 180.]

FORTY-THIRD MEETING, NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

Held in Young's Hotel, Boston, Mass., Feb. 19 and 20.

First Day—Morning Session.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS—*Continued.*

Damage and Danger Produced by Stray Electric Currents on Underground Piping.—It has already been pointed out that damage from electrolysis to underground piping usually results in the neighborhood of the power station from current leaving the pipe to flow to the rails and to other return conductors, and that service pipes in the same locality are most frequently damaged where they cross under and are positive to trolley rails. The destruction of underground piping by electrolysis is, however, by no means confined to the so-called positive districts in the neighborhood of the railway power station, but will occur at any point in the pipe where current leaves the pipe to flow to the surrounding soil. In Fig. 10 is shown a water

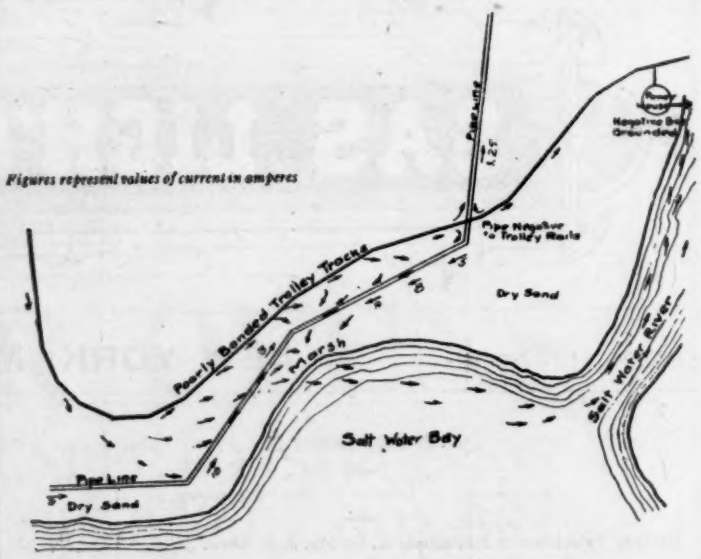


Fig. 10.—Diagram Showing Stray Current Leaving Water Main in Negative District.

pipe and trolley line near a salt water bay, about 8 miles distant from the railway power station supplying this trolley road. The trolley rails at this point are about 25 volts positive to the water pipe; that is, the water pipe is in a highly negative district. The railway power station is located on the shore of a salt water bay, and its negative bus-bar is grounded through low resistance ground connections, so that large currents leak from the trolley rails at points shown in Fig. 10, and flow through the ground and the salt water of the bay to return to the negative bus-bar at the railway power station. These stray currents in their path encounter the water pipe and flow part of the way thereon. The values of current indicated on the pipe are average values obtained from 24-hour records. It is seen that in one section large currents leave this water pipe to flow to the surrounding soil and from there to the salt water. An examination of the pipe at this point also indicated that it had been badly corroded by electrolysis. This, therefore, affords an excellent example of destruction by electrolysis of a water pipe in a highly negative district.

In Fig. 11 is also shown a water main and service pipe crossing un-

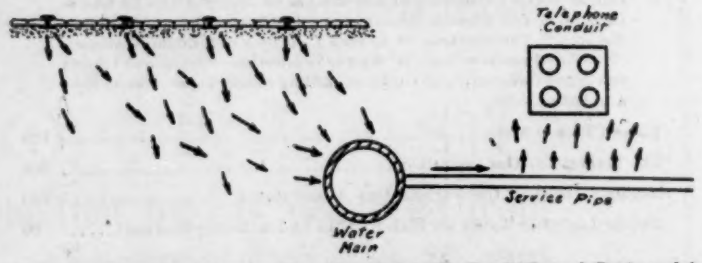


Fig. 11.—Example of Service Pipe Negative to Trolley Rails and Destroyed by Electrolysis Due to Currents Flowing from Rails to Pipe and from Pipe to Telephone Cable Sheaths.

der trolley rails and under telephone ducts. At this point the pipe is also negative to the trolley rails, but positive to the lead sheaths of the telephone cable, the potential condition with reference to the cables being caused by the fact that the telephone cable sheaths are bonded to the railway return conductor at the power station. As shown in the diagram, current flows from the rails to the water pipe, and leaves the water service pipe where it crosses under the telephone ducts to flow to the cable sheaths, resulting in the destruction of the service pipe. An examination showed pits extending entirely through the service pipe, directly under the telephone ducts and facing the ducts. This, therefore, affords another illustration of destruction of a service pipe in a negative district.

Besides danger from electrolytic destruction of the pipes, stray currents, where they flow on underground piping systems, frequently enter buildings through service connections and produce a serious fire hazard. For example, current may flow into a building through a water service pipe, then flow from the house water piping to the house gas piping, and then out from the building through the gas service pipe. An example of this kind frequently met in practice is illustrated in Fig. 12. Such contacts between service pipes, or between a service pipe and the lead sheathing of a telephone or a power cable, frequently occur through metal ceilings, or where the pipes rest against each other. Since dangerous heating may be produced

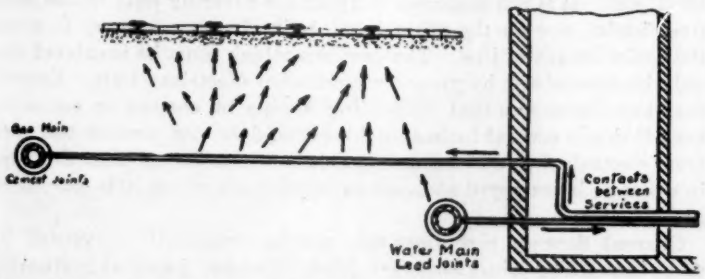


Fig. 12.—Diagram Showing Stray Currents Entering and Leaving Building Through Service Pipes and Causing Fire Hazard and Also Destroying Gas Service Pipe by Electrolysis

where the current flows through such contacts, or where vibration may momentarily separate the contacts and produce an arc, nearby inflammable material is in danger of being set on fire. The author has in fact found many cases where currents up to 30 amperes were flowing into-and-out of buildings through service pipes or lead cable sheaths. Evidences of arcing having occurred between such contacts in buildings have also been found. There is no doubt that many fires have started in this way, but it is always difficult to prove the cause of a fire because of the destruction resulting from the fires.

Corrosion Not Caused by Electrolysis.—While electrolysis is undoubtedly responsible for much destruction of underground piping and other underground metallic structures, the author has frequently been asked to examine cases where the destruction had clearly not been produced by electrolysis from stray currents, but by altogether different causes. It must be remembered that corrosion of a metal from electrolysis can only occur where current leaves the metal to pass to an electrolyte, such as damp soil. Service pipes have sometimes been found destroyed inside of cellar walls where they were not in contact with an electrolyte; the corrosion here is purely of a chemical nature, and not in any way chargeable to stray current electrolysis. Brass or copper pipes and fittings and brass condenser tubes in contact with salt water also corrode quite generally, but this is caused by electrochemical action of the salt or contaminated water upon the metal, and not by electrolysis from stray currents.

Remedial Measures.—The only one complete remedy for electrolysis is the use of a completely insulated return circuit. Such railways may be provided with double overhead trolley wires, as used (for example) in Cincinnati and Havana, Cuba; or with an insulated outgoing and return conductor in underground conduits, as used (for example) on the surface lines on Manhattan Island and in Washington, D. C.; or with separate insulated third and fourth rails for the outgoing and return current, as is used on the Metropolitan District Railway in London. With these systems the running tracks are not used as a part of the electric circuit, and as both positive and negative sides of the circuit are insulated no stray currents are produced.

Where a road operates on private right-of-way the rails can often be practically insulated from ground and the escape of current from the tracks prevented. For surface roads this can be practically accomplished by placing the rails on wooden ties above ground, using broken stone for ballast and keeping the rails out of contact with ground. In the case of railway lines operating on elevated structures the rails can be fastened to wooden ties and kept out of contact with the structure. These rails, supplemented where necessary with negative feeder cables, also insulated from the structure, can then be used for the return conductor. In this way the return circuit is quite thoroughly insulated ftom the elevated structure and from ground, and stray currents are entirely prevented.

A number of remedial measures intended to reduce stray currents from electric railways using the grounded rails for a return conductor have been tried. These methods may be divided into two classes, the first class aiming to remove the current harmlessly from pipes by metallic connections or bonds between the pipes and the railway return circuit, the second aiming to minimize stray currents through ground.

Since stray currents cause damage only where they leave pipes to flow to the surrounding soil, attempts are frequently made to prevent destruction from electrolysis by connecting or bonding the pipes or other structures by means of metallic conductors to the rails or to the negative return circuit, so as to remove the electric current by metallic conduction and thus prevent corrosion from electrolysis. As the lead sheaths of underground cables form continuous and uniform metallic conductors, it is, therefore, possible to protect such cable sheaths against electrolysis by bonding or connecting them to the railway return circuit. This practice is, however, exceedingly objectionable because by such bonding the trolley rails are paralleled by a low resistance grounded conductor which greatly increases the tendency for current to flow through ground from the tracks. The second objection is that such bonding makes the cable sheaths negative to all other underground structures, such as water and gas pipes, thereby setting up a tendency for current to flow from such pipes to the cable sheaths. This effect is illustrated in Fig. 13. In this a case

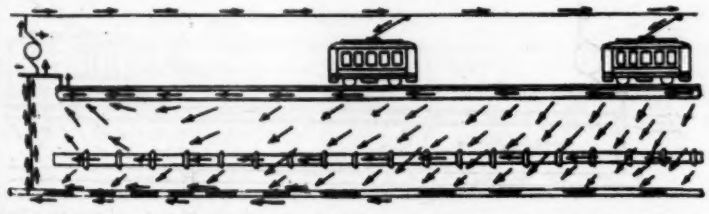


Fig. 13.—Diagram Showing Path of Stray Railway Currents and Showing Effect of Bonding Underground Lead Cable Sheaths to Negative Bus-Bar of Power Station.

is shown, frequently found in practice, where the pipe is everywhere negative to the trolley rails, except in a very restricted area in the immediate vicinity of rail feeder connections, but is everywhere positive to the underground cable sheaths. The pipe is consequently everywhere in danger from stray current flowing from the pipe to these cable sheaths. In one city, in fact, where there was an underground cable system with its lead sheathing bonded to the railway return circuit, it was found that the underground pipes were everywhere negative in potential to the trolley rails, and were, therefore, considered immune from electrolysis. An investigation showed, however, that these pipes were at all points highly positive to the underground cable sheaths and were in fact in considerable danger from electrolysis. It has been frequently found that, where gas or water service pipes cross bonded cable sheaths, currents are caused to flow from the service pipes to the cable sheaths, and produce gradual destruction of the service pipes. A case of this kind was illustrated in Fig. 11. In the case of one city 19 service pipes were destroyed in the course of 1 year directly where these pipes cross telephone ducts containing cables whose sheaths were bonded to the railway return circuit. This method of bonding, therefore, protects continuous conductors like lead cable sheaths, but at the expense of other underground metallic structures which cannot be so treated. Its effectiveness as a protective means depends absolutely on uniformity of conductivity of the conductor to be protected, but it is not generally applicable to underground piping systems, because the latter do not form continuous electrical conductors, but are more or less discontinuous networks. While lead calked joints usually have a relatively low resistance, it frequently happens that they develop such high resistances as to make them practically insulating joints, due undoubtedly to the formation of oxide coatings. Cement joints and cement pipes have such a high resistance compared with iron pipes that they are practically insulating.

Bonding of pipes to the rails or to the negative return circuit can only afford local protection to the extent that the piping connected forms a continuous metallic conductor, and this latter is an unknown and indeterminate quantity in a piping network. In the practical working out of a bonding or drainage system two opposing tendencies develop; first, there is a reduction in the difference of potential between pipes and rails in the positive areas, and consequent reduction of damage in those areas; and, second, there is an increase of current flow on the pipes throughout the entire system, thus increasing the danger of trouble at high resistance joints, or other places where two piping systems or separate portions of the same system are electrically discontinuous. As a rule, in the early stages of this system, and especially in small networks when there are comparatively few bond connections, and the resistances of the paths over the pipes are, therefore, relatively high, the effect is apt to be beneficial, reducing the danger in positive areas more than it increases the danger elsewhere. As the system grows and the load increases, more and heavier bonds become necessary. The current on the pipes may finally become so great that the trouble from current shunting around joints, or between separate systems, will increase more rapidly than the danger in the positive areas is reduced, and any further increase in the bonding becomes an actual source of danger to the system. Since bonding transfers the trouble from the region where it was most evident to a new locality where it may require several years to manifest itself, the false impression is created that the trouble has been removed. It is due largely to this obscure manner in which trouble

develops that has caused this method to become quite widely used. A number of cases have, in fact, been reported where a main bonded to the negative return circuit at the power station was completely destroyed by electrolysis a block or two away, because of a high resistance joint in the main forcing current to shunt around the joint and leave the main a short distance away from the power station. A case of this kind is illustrated in Fig. 14. In another case, the water

Fig. 14.—Diagram Showing Increased Danger from Electrolysis from Bonding Pipe to Rails Caused by Accidental High Resistance Joint in Pipe.

main on one side of the street was bonded to the negative return circuit at the power station, and a main on the opposite side of the same street, although connected through cross-piping to the bonded main, was completely destroyed because high resistance joints had developed in the connecting pipes.

Among the methods which have been used to minimize the escape of currents on systems using the grounded rails for the return conductor are increasing the resistance between rails and ground, increasing the resistance between pipes and ground, increasing the resistance along the line of the pipe by means of high resistance joints, and decreasing the drop in potential in the grounded rails.

The resistance between rails and ground can often be increased by using broken stone ballast, whereby the rails are kept out of contact with ground, and water is allowed to trickle away from the rails, thereby maintaining high resistance between the rails and ground. Where an electric railway owns its own right-of-way, it is frequently feasible, as already stated, to practically insulate the rails from ground.

Attempts have been made to insulate pipes from ground by paints, dips and insulating coverings. Experience, as well as a large number of tests on such paints and dips have, however, shown that no dip or paint will protect a pipe against electrolysis in wet soil. The first difficulty is the mechanical one of applying the paint so as to form an absolutely perfect coating, and then to prevent mechanical damage to the coating. Where imperfections exist or develop aggravated trouble always ensues. Experience further shows that, even where paints or dips are apparently intact and perfect, electrolytic action is not prevented; and, in fact, very serious electrolytic pittings have been found under apparently good coatings. It has been found that in most cases the coatings applied have either been completely destroyed by the effects of the wet soil and the electric currents, or defects in the coating have developed causing concentrated corrosion at such defective spots. The destruction of paints in wet soil, where subjected to an electric current, is due to traces of moisture finding their way through the coating, giving rise to the flow of a feeble current and resulting in a very slight amount of electrolysis. The gas and other products of electrolysis then form blisters and finally rupture the coating. Pipes in positive districts covered with imperfect insulating coatings, are in greater danger from electrolysis than bare pipes. Coating pipes in negative districts with insulating covering does some good in reducing the amount of stray current which reaches the pipes. Where it is attempted to apply a heated material, like pitch or asphaltum, to a cold pipe, it is impossible to completely cover the pipe. The only kind of insulating covering which appears to afford certain protection is a layer of at least 1 or 2 inches of a material like coal tar pitch or asphaltum, of such a grade that it is not brittle and so will not crack, but yet is hard enough to remain in place. The best way to apply such a layer is to surround the pipe with a wooden box, support the pipe upon creosoted blocks of wood, or upon blocks of glass, and then fill the space between the box and pipe with the molten material. As a further protection an insulated coupling should be introduced at each end of the section, covered so that, even if the covering should become defective at any point or points, no current can reach the pipe to corrode it by electrolysis. A pipe treated in this way, with the work done so as to be mechanically perfect, would undoubtedly be protected from electrolysis. However, the cost of carrying out such an installation is absolutely prohibitive, except in a few special cases, such as service pipes in very bad localities, or in the case of some very important individual pipe lines of small size. It is not sufficient to apply the covering only in the positive district, nor on the other hand, is it always necessary to cover the entire length of line. The portions which must be insulated can only be determined by properly conducted electrical tests. Experience has also shown that embedding a pipe in cement or concrete, even if this is several inches in thickness, does not protect the pipe from electrolysis, and in some cases it has been found that the pipe in concrete is destroyed at least as rapidly as when it is buried in ground.

Current flow on pipe lines can also be practically prevented by using insulating joints for every joint. Cement joints as ordinarily made do not generally produce metallic connection between the two pipes, and may practically be classed with insulating joints. The cause of the high resistance of cement joints is probably due to the fact that, although every attempt is made to push the spigot end home into the bell when laying cast iron pipe, as a matter of fact in most cases the two pipes are not in metallic contact. Even where there is metallic contact this is probably over a comparatively small area, if not at a point. As the end of the spigot is always heavily coated with scale, such metallic contact generally forms a poor electrical connection of comparatively high resistance. It is a simple matter to positively prevent metallic contact by inserting a ring of some cheap insulating material, such as fiber or cardboard, between the end of the spigot and the interior of the bell, and this has been done in some cases. The resistance of cement joints is, then, the electrical resistance of the cement intervening between the spigot and bell, and while cement is not an insulator, but, on the contrary, is probably as good a conductor as ordinary soil, yet, compared with iron, the resistance is so high that the cement joints practically interrupt the electrical continuity of the pipe line. A pipe line laid with all cement joints or with all insulating joints is, therefore, a discontinuous electrical conductor and is not capable of carrying stray electric currents. Such a pipe line, therefore, cannot pick up current in an extensive negative area to discharge it in a restricted positive area, which is generally the cause of the most serious electrolytic danger. For this reason a piping system with all cement or insulating joints is, on the whole, much less likely to be affected by electrolysis than a piping system with all lead or screw coupling joints. Experience has shown, however, that a cement jointed piping system is by no means immune from electrolysis, and there is abundant experience which shows that cement jointed mains, and especially service pipes from such mains, can suffer severely from electrolysis. In these cases the stray currents reach the mains and service pipes from other pipes or by other paths. An example of a gas service pipe from a cement jointed main destroyed by electroysis from stray currents which reached the gas service pipe from the water piping is illustrated in Fig. 12.

A convenient form of insulating joint for small wrought iron or steel pipes is the Macallen, illustrated in Fig. 15. This is very largely

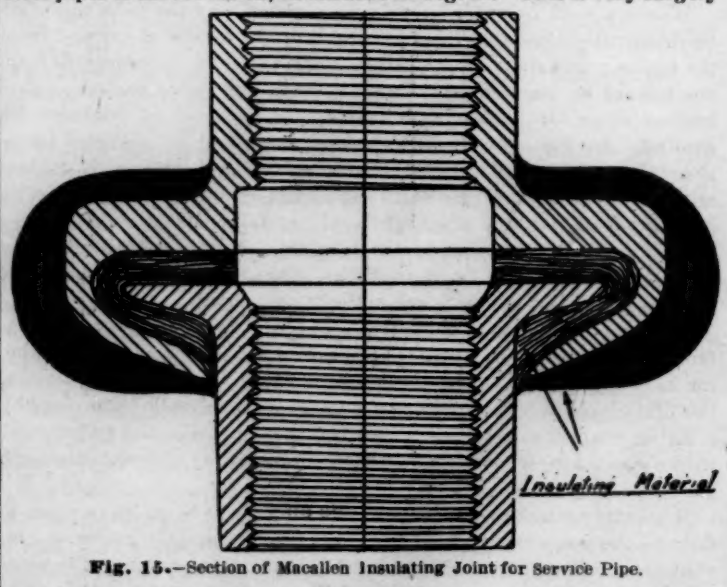


Fig. 15.—Section of Macallen Insulating Joint for Service Pipe.

used for insulating water and gas service pipes. A convenient form of insulating joint for large pipes is illustrated in Fig. 16, where a flanged joint is shown with a fiber disc between the surfaces of the flanges, the bolts being insulated with fiber tubing and the bolt heads and nuts insulated with fiber washers. This form of flanged insulating joint has been very largely used for water and gas mains.

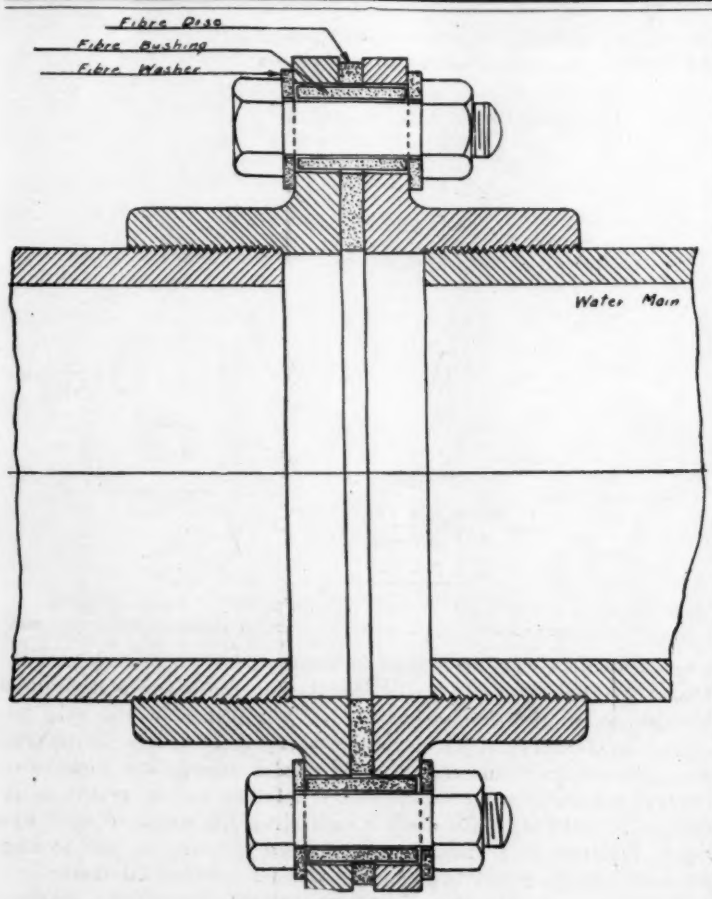


Fig. 16.

The Dresser insulating joints are also very satisfactory. Insulating joints can often be used to great advantage in special cases; as, for example, in the case illustrated in Fig. 12, where an insulating joint in the gas service inside of the building would protect the gas service pipe by preventing the current from flowing out of the building on this pipe. Insulating joints on mains must, however, be used with very great caution, as they can under unfavorable conditions do more harm than good. It is sometimes possible to use comparatively few insulating joints to break up the electrical continuity of a pipe line and protect the pipe line from electrolysis, but such joints must be installed only after careful tests have shown that the current is not likely to shunt through ground around them. This depends largely upon the potential gradient through ground and upon the electrical resistance of the ground.

While relief from serious electrolysis can at times be obtained by such special measures as insulating pipe coverings or insulating joints, it must be understood that all remedial measures should have for their first aim the reduction of the drop in potential in the rails to a minimum, because this removes the cause of the trouble. The first and most important step necessary to accomplish this is to maintain the rails perfectly bonded, so that the rails themselves form continuous electrical conductors. The next important step is to limit the radius from the power station to which the station supplies electric power, so that current does not have to be returned from excessive lengths of rail lines to any one power station. This is usually accomplished in practice by supplying power to electric railways from distributed substations. The next step is to remove the current from the rails wherever there is concentration of current by means of insulated return feeders connecting from the rails at these points to the power station. In order that such insulated return feeders should be most efficient in reducing drop in potential in grounded rails these feeders should be proportioned for equal drop, so that the rails at all points where return feeders are connected are maintained at substantially the same potential under average load conditions. This also requires that the rails immediately in front of the power station must not be connected directly to the negative bus-bar, unless a resistance corresponding to the average resistance of the return feeders is connected in this circuit. Where it is necessary to bring current back from a distant point in the rails it is sometimes more economical to employ a negative booster in series with this return feeder rather than make this feeder of such large cross-section as would be required to maintain the distant point in the rails at the same potential as the nearer connection points. With this system part of the voltage drop is actually removed from the rails and transferred to the insulated return feeders from which current cannot leak to ground.

An illustration of such an insulated return feeder system, proportioned for equal drop, is shown in Fig. 17. In this illustration it is

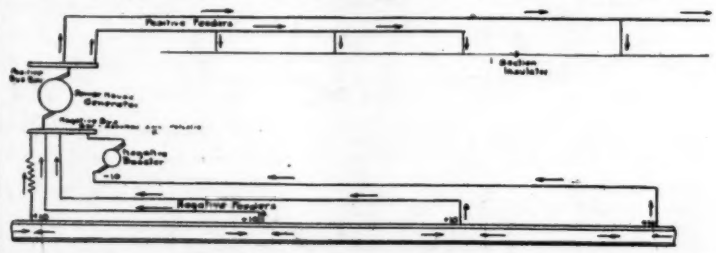


Fig. 17.—Diagram of Single-Trolley Railway With Insulated Return Feeders and Negative Booster Showing Path of Currents and Assumed Rail Potentials.

assumed that the negative bus-bar is at zero potential and that the return feeder connection points on the rails are maintained at a potential of 10 volts with reference to the negative bus-bar. Under these circumstances there is no tendency for current to flow from the rails between points where feeders are connected to the rails. The drop of 10 volts in the return feeders has also been removed from the rails.

The possibilities in the way of reducing stray currents by means of properly proportioned insulated return feeders was clearly shown by Mr. George I. Rhodes, in a paper entitled "Some Theoretical Notes on the Reduction of Earth Currents from Electric Railway Systems by Means of Negative Feeders," published in the Transactions of the American Institute of Electrical Engineers for 1907. A few of the figures from Mr. Rhodes' paper are reproduced in Fig. 18, with diagrams illustrating the application of these figures. It will be seen that, with the negative bus-bar grounded through a ground connection of negligible resistance, in addition to being connected to the rails at the power station, the grestest amount of stray current is produced, which is assumed unity for purpose of comparison, This is illustrated by Diagram A, Fig. 18. Disconnecting the negative

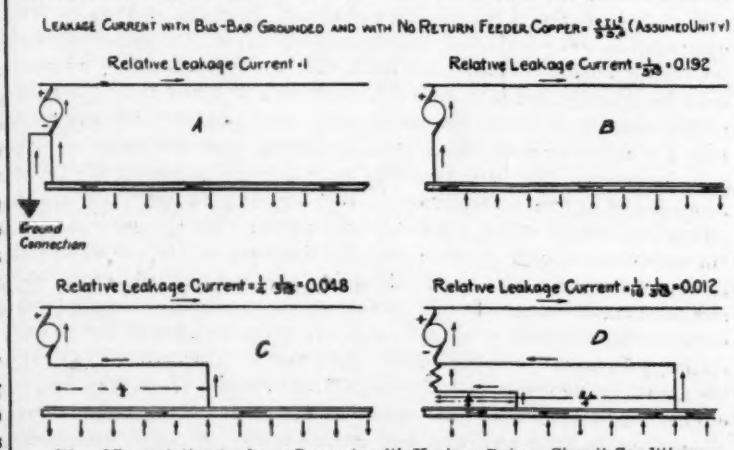

Leakage Current with Bus-Bar Grounded and with No Return Feeder Copper = $\frac{E I^2}{S S^2}$ (Assumed Unity)
Relative Leakage Current = 1
A
Ground Connection
Relative Leakage Current = $\frac{1}{5.8}$ = 0.192
B
Relative Leakage Current = $\frac{1}{4}$ $\frac{1}{5.8}$ = 0.048
C
Relative Leakage Current = $\frac{1}{10}$ $\frac{1}{5.8}$ = 0.012
D

Fig. 18.—Relative Leakage Currents with Various Return Circuit Conditions.

bus-bar from ground connections at the station, but not from rails, reduces stray currents to one-fifth their former value, as illustrated by Diagram B of Fig. 18. Disconnecting the negative bus-bar from ground connections and from the rails at the power station, and returning the current by means of one insulated return feeder from the center of the line, reduces stray currents to 5 per cent. of their former value, as illustrated by Diagram C of Fig. 18. By using two insulated return feeders with the negative bus-bar insulated, the stray currents are reduced to 1.2 per cent. of their former value, as illustrated by Digram D of Fig. 18. It, therefore, can be seen that very great reduction of stray currents can be accomplished by insulating the negative bus-bar at the power station from ground connections and from rails, and returning the current by means of insulated return feeders.

Since power stations are usually located near the center of load of an electric railway system, it is usual in cities to find railway lines radiating out from the power station. Where the running tracks are connected to the negative bus-bar only in the immediate neighborhood of the power station, these running tracks are depended upon alone to return current to the power station, and there is consequently always very great concentration of stray current under these circumstances in the neighborhood of the power station. Such railway lines radiating out from the power station are illustrated diagrammatically in Fig. 19. In this figure 8 railway lines are assumed

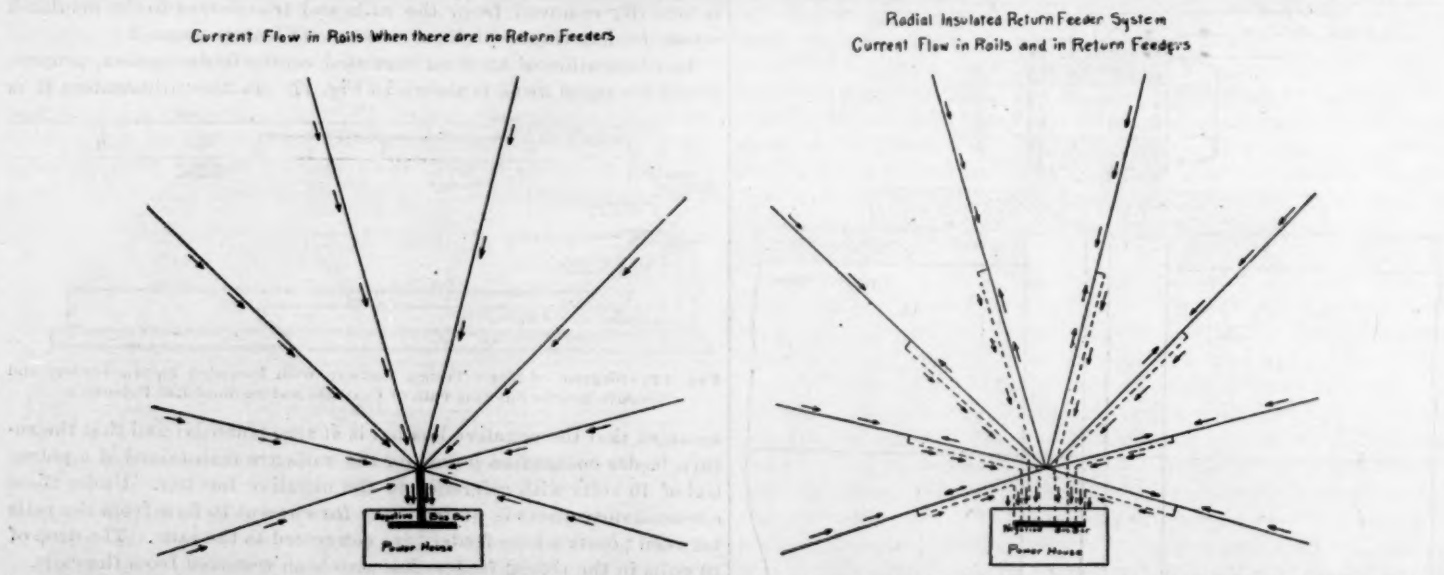

Current Flow in Rails When there are no Return Feeders
Power House
Radial Insulated Return Feeder System
Current Flow in Rails and in Return Feeders
Power House

Fig. 19.—Diagrams Showing Trolley Lines Radiating Out from Power Station with or without Insulating Return Feeders and Showing Path of Return Currents.

radiating out from the power station. In the left-hand diagram of Fig. 19 the rails of these lines are shown connected to the negative bus-bar at the power station only. It is seen that, as the result of this, all of the current used on the 8 railway lines flows in the rails towards the power station. The stray currents which leak from the rails to ground also concentrate in ground and on the underground piping in the neighborhood of the railway power station, where they must return to the rails to get back to the negative bus-bar.

If this connection between the negative bus-bar and the rails at the power station were removed, and the currents returned from the rails at points near the center of each railway line by means of insulated return feeders, as shown in the right-hand diagram of Fig. 19, this concentration of current in the neighborhood of the power station would be entirely removed. With this arrangement, the current used by each individual line would tend to flow away from the rails at points away from the center of each line, and towards the rails near the center of each line. It is, therefore, seen that there is only ¼ of the current returning from the rails at any one point than there is when the rails are connected to the negative bus-bar only at the power station. Further, the total stray current through ground with the conditions shown in the right-hand diagram will be only ¼ of the total stray current with the conditions of the left-hand diagram, assuming similar soil conditions, so that at any 1 point the danger from electrolysis will be $\frac{1}{16}$ of what it is in the neighborhood of the power station with the first arrangement. As a matter of practice, however, the actual reduction is very much greater, because the return feeder connection points on the rails can be chosen so as to be located where the ground is high and dry, and consequently of high resistance, while the railway power station is generally located near water, where the ground is wet and of low resistance. Instead of connecting one insulated return feeder to the middle point of every line, as indicated in Fig. 19, a number of such feeders may be connected to a number of properly selected points in every line. In this way the drop in the rails, and consequently also the stray current produced, can be reduced to any desired value. In many cases the benefit to be derived at comparatively small cost from insulated return feeders with negative bus-bar insulated is much greater than above indicated. This is particularly true when the power house is at one side of a main network of tracks and connected to it only by a single branch line. To connect the negative bus-bar to the tracks of this single branch at the power house means concentrating the major part of the track drop within a short distance of the power station. In such case, the insulation of the negative bus-bar, and the use of insulated return feeders to the central rail network, will at once take the greater part of the drop out of contact with ground. This will eliminate the greater part of the cause of the trouble, as well as enormously reduce the concentration of the remaining stray current in the positive district. Thus the advantage gained by insulating the negative bus-bar is often very much greater than that indicated for the typical case above described.

The reduction of drop in potential in rails, for the purpose of minimizing electrolysis, is the basis for various regulations and ordinances which have been enacted for the purpose of protecting underground metallic structures from electrolysis. For example, the well known English Board of Trade Regulations limit the maximum allowable potential difference between any 2 points in the rails to 7 volts. In Germany, a joint committee, representing the electric railway, gas and water interests, has adopted a regulation limiting the average allowable potential difference between any 2 points in the rails to 2 5 volts within a district encircling the urban district by a radial distance of 2 kilometers. Beyond this circle, the average potential drop in the rails must not exceed 1 volt per kilometer.

Where railway return circuit improvements have been made, to such an extent that there are no longer any excessive drops in the grounded rails, it is generally found that stray currents on underground pipes are reduced to small and often negligible amounts. Where, however, stray currents which are considered too large for safety are still found on such underground pipes after the railway return circuit has been thoroughly improved, then it is frequently possible and feasible to apply one or more of the other remedial measures, such as insulating joints in the pipes to take care of the small remaining stray current. Such other remedial measures, as bonding or insulating joints in pipes, must, however, never be applied unless the railway return circuit has been improved sufficiently to eliminate all excessive drops in the grounded rails.

SUMMARY AND CONCLUSIONS.

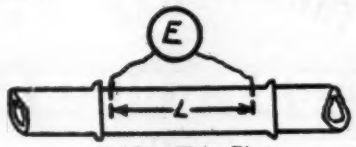
Experience shows that where there is serious trouble from electrolysis caused by large stray currents leaking from street railways, the bulk of this trouble is due to defective rail bonding, to ground connections from the negative bus-bar, and to lack of return feeders to bring current back from the rails to the power station. While stray currents can only be entirely eliminated by insulating the return circuit by the use of a double trolley, either overhead or in conduit, it is nevertheless a fact, which is not generally appreciated, that where large stray currents exist, due to the above causes, these can always be reduced to a small fraction of their present value by removing all ground connections of the negative bus-bar, and installing insulated return feeders proportioned for equal drop from radially disposed points in the track system located at some distance from the power station. By this method the rails are drained of current, and any desired part of the voltage drop can be removed from the rails and transferred to insulated conductors from which currents cannot leak. In Europe such radial insulated return feeders, for bringing current back from the rails to the power station, are made necessary by regulations limiting the allowable drop in voltage in the rails; and, in most cases, such installations of insulated return feeders have substantially removed serious trouble from electrolysis. This system of minimizing stray currents by means of radially disposed insulated return feeders has also been installed in a number of American cities, and the method is becoming recognized by railway engineers as by far the best for minimizing stray currents. This system in fact removes the root of the trouble, by draining the rails of current and removing voltage drop from the rails and thus preventing substantial leakage of current through ground, and is, therefore, correct in principle. The railroad companies freqently object

Table for Determining Current Flow on Iron Pipes from Millivolt Drop Along Continuous Length of Pipe.
Computed by Albert F. Ganz, M.E.

L = Distance between contacts, feet.
E = Instrument reading, millivolts.
K = Constant from table.

Current flow, amperes = $\frac{KE}{L}$

Wires must not span joint.



Cast Iron Water Pipe.

American Water Works Association Standard—Adopted 1908. Weight 1 cubic foot = 450 pounds Resistance 1 pound foot = 0.00144 ohm.

Design.	Nominal Diam. of Pipe.	Weight per Foot Exclusive of Bell.	Resistance per Foot Exclusive of Bell.	K Current for 1 Millivolt Drop per Foot of Continuous Pipe.
	ins.	*lbs.*	*ohm.*	*amps.*
100 feet head, 43 pounds pressure.	4	18.1	0.0000795	12.6
	6	27.9	0.0000516	19.4
	8	38.8	0.0000371	27.0
	10	52.1	0.0000276	36.2
	12	67.1	0.0000215	46.6
	14	82.5	0.0000175	57.3
	16	99.0	0.0000146	68.7
	18	118.	0.0000122	82.0
	20	138.	0.0000104	95.8
	24	187.	0.0000077	130.
	30	267.	0.00000539	185.
	36	359.	0.00000402	249.
	42	465.	0.00000310	323.
	48	609.	0.00000236	423.
	54	733.	0.00000196	509.
	60	838.	0.00000172	583.
	72	1170.	0.00000123	813.
	84	1450.	0.000000994	1010.
200 feet head, 86 pounds pressure.	4	20.1	0.0000716	14.0
	6	31.2	0.0000462	21.6
	8	42.7	0.0000337	29.7
	10	59.0	0.0000244	41.0
	12	76.6	0.0000188	53.3
	14	95 0	0.0000152	66.0
	16	115.	0.0000125	79 9
	18	138.	0.0000104	95.9
	20	163.	0.00000884	113.
	24	218.	0.00000661	151.
	30	313.	0.00000460	217.
	36	419.	0.00000344	291.
	42	544.	0.00000265	379.
	48	689.	0.00000209	479.
	54	847.	0.00000170	588.
	60	1010.	0.00000143	702.
	72	1420.	0.00000101	986.
	84	1880.	0.000000767	1310.
300 feet head, 130 pounds pressure.	4	21.3	0.0000676	14.8
	6	33.0	0.0000436	22.9
	8	48.1	0.0000300	33.4
	10	65.6	0.0000219	45.5
	12	85.6	0.0000168	59.5
	14	108.	0.0000133	75.0
	16	134.	0.0000107	93.1
	18	163.	0.00000884	113.
	20	191.	0.00000754	133.
	24	258.	0.00000558	179.
	30	368.	0.00000392	256.
	36	498.	0.00000239	346.
	42	659.	0.00000218	458.
	48	834.	0.00000173	579.
	54	1040.	0.00000138	723.
	60	1220.	0.00000118	847.
	72	1750.	0.000000823	1220.
400 feet head, 173 lbs. pressure.	4	22.8	0.0000631	15 8
	6	35.4	0.0000407	24.6
	8	51.2	0.0000282	35.6
	10	71.6	0.0000202	49.7
	12	93.9	0.0000153	65.2
	14	119.	0.0000121	82.6
	16	148.	0.00000973	103.
	18	179.	0.00000805	124.
	20	213.	0.00000676	148.
	24	286.	0.00000503	199.
	30	422.	0.00000342	293.
	36	583.	0.00000247	405.
	42	765.	0.00000188	532.
	48	962.	0.00000150	668.
	54	1230.	0.00000117	854.
	60	1460.	0.000000987	1014.
500 feet head, 217 lbs. pressure.	6	37.8	0.0000381	26.2
	8	56.7	0.0000254	39.4
	10	78.9	0.0000182	54.7
	12	104.	0.0000138	72 2
	14	133.	0.0000108	92.4
	16	165.	0.00000873	115.
	18	203.	0.00000710	141.
	20	241.	0 00000598	167.
	24	329.	0.00000438	228.
	30	481.	0.00000300	334.
	36	668.	0.00000216	464.
600 feet head, 260 lbs. pressure.	6	39.6	0.0000364	27.5
	8	60.7	0.0000237	42.2
	10	84.7	0.0000170	58.9
	12	113.	0.0000127	78.5
	14	146.	0.00000987	101.
	16	181.	0.00000795	126.
	18	220.	0.00000654	153.
	20	266.	0.00000541	185.
	24	362.	0.00000398	251.
	30	539.	0.00000267	375.
	36	754.	0.00000191	523.

Table for Determining Current Flow on Piping from Millivolt Drop Along Continuous Length of Pipe.—Continued.

Cast Iron Gas Pipe.
American Gas Institute Standard—Adopted 1911.
Weight 1 Cubic foot = 450 Pounds
Resistance 1 Pound-foot = 0.00144 ohm.

Nominal Diam. of Pipe.	Weight Per Foot, Exclusive of Bell.	Resistance Per Foot, Exclusive of Bell.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	*Pounds.*	*Ohm.*	*Amperes*
4	17.3	0.0000833	12.0
6	27.3	0.0000528	19.0
8	38.0	0.0000379	26.4
10	51.1	0.0000282	35.5
12	67.1	0.0000215	46.6
16	102.	0.0000141	70.9
20	140.	0.0000102	97.1
24	187.	0.00000770	130.
30	258.	0 00000559	179.
36	346.	0.00000416	240.
42	453.	0.00000318	314.
48	609.	0.00000237	423.

Standard Wrought Iron Pipe.
Resistance 1 Pound-foot = 0.00181 ohm.

Nominal Diam. of Pipe.	Weight Per Foot.	Resistance Per Foot.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	*Pounds.*	*Ohm.*	*Amperes.*
⅛	0.24	0.000754	1.33
¼	0.42	0 000431	2 32
⅜	0.56	0.000324	3.09
½	0.84	0.000216	4.64
¾	1.12	0.000162	6.18
1	1.67	0.000108	9.23
1¼	2.24	0.0000808	12.4
1½	2.68	0.0000676	14.8
2	3.61	0 0000501	20.0
2½	5.74	0.0000316	31.7
3	7.54	0.0000240	41.7
4	10.66	0.0000170	58.8
6	18.76	0.00000965	104.
8	28.18	0.00000643	156.
10	40.00	0.00000452	222.
12	49.00	0.00000370	271.

Standard Steel Pipe.
Resistance 1 Pound-foot = 0.00021 ohm.

Nominal Diam. of Pipe.	Weight Per Foot.	Resistance Per Foot.	K Current for 1 Millivolt Drop Per Foot of Continuous Pipe.
Inches.	*Pounds.*	*Ohm.*	*Amperes.*
⅛	0.24	0.000873	1.14
¼	0.42	0.000500	2.00
⅜	0.56	0.000376	2.66
½	0.84	0.000250	4.00
¾	1.12	0.000188	5 33
1	1.67	0.000126	7.95
1¼	2.24	0.0000937	10.7
1½	2.68	0.0000784	12.8
2	3.61	0.0000582	17.2
2½	5.74	0.0000366	27.4
3	7.54	0.0000278	35.9
4	10.67	0.0000197	50.8
6	18.76	0.0000112	89.4
8	28.18	0.00000745	134.
10	40.07	0.00000524	191.
12	49.00	0.00000428	234.

(*Continued on page* 194.)

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NOTICE TO ADVERTISERS.

New Advertisements and changes of copy therefor should be in hand Wednesday noon of week prior to date of issue.

NEW YORK, MONDAY, MARCH 24, 1913.

[Official Notice.]

Fifth Annual Meeting, Pennsylvania Gas Association.

Pennsylvania Gas Association,
Office of the Secretary,
West Chester, Pa., March 1, 1913.

The Fifth Annual Convention of the Pennsylvania Gas Association will be held at York, Pa., on Wednesday, Thursday and Friday, April 9th, 10th and 11th, 1913. The headquarters will be at the Colonial Hotel. The Committee requests a prompt reply on the inclosed postal, that reservation may be made for each member attending the meeting. The papers promised are:

"High Pressure Distribution," by Mr. C. M. Cole, Harrisburg, Pa.
"Valuations of Gas Companies for Rate Making," by Mr. Grier Hersh, York, Pa.
"Industrial Gas Appliances," by Mr. E. C. Romain, Reading, Pa.
"Gas Company Classification and Accounting," by Mr J. Wittaker, Fernley, Philadelphia, Pa.
"Demonstration of the Use of the Pulmotor," by Mr. Conner, Philadelphia, Pa.

In addition to the above papers there will be the following list of topics for discussion: "Selling Campaigns," "Lighting and Heating Appliances," "House Piping," "Advertising," "Meeting Competition," "Methods of Handling Orders in the Office," "Methods of Handling Merchandise Orders, Office to Shop," "Educating Order Men," "Prepayment Meters," "Waste Heat Boilers," "Coal Gas," "Photometry and Calorimetry in Small Works," "Checking Work Done by Order Men."

Entertainment.

Wednesday Night.—Theater party.
Thursday.—Trip to Gettysburg battlefield as the guests of the York Gas Company.
Friday Night.—Informal dinner and smoker. Tickets for theater and dinner-smoker $5.

The members are requested to return postal card notice to Mr. Philbrick, at once, that, with your help thus rendered, the work of the Committee may be successfully carried out.

W. O. Lamson, Secretary.

[Special Editorial Correspondence, by Telegraph.]

NINTH ANNUAL MEETING, ILLINOIS GAS ASSOCIATION.

Chicago, March 19, 1913.

The Illinois Gas Association was convened at 10 o'clock this morning, in the beautiful Red Room of the handsome La Salle Hotel. We were greeted with sunshine, but the air was cool and the winds blustered in from the tossing waters of the grest lake. The initial attendance seemed to betoken a not too large gathering, in that only perhaps one hundred answered to the roll call when President Channon had the business under way. The report of the Board of Directors evidenced that the Association was numerically strong as to members and satisfactorily firm financially. While the election of new members this year did not average up to the large totals of former years, this is easily accounted for when one recalls the fact that the general membership represents possibly a larger percentage of the companies in Illinois, than is shown by the rolls of any other state gas association. In any event no one can truthfully deny that the fraternal spirit, as fashioned by the Association, becomes stronger each year. President Channon's address, while short as to text was pointed as to the matters with which it dealt. Prominent in its suggesting was the importance of moulding public opinion so that a Public Service Corporation might soon be a thing of fact in Illinois. He also in this connection emphasized the security that such a commission gave to investments of a permanent sort. A further note of warning spoken in a very temperate way called attention to the substitution of coal gas for water gas, made necessary by the great increase in the price of enriching oils. The address was listened to with close attention and many of its more salient points were loudly applauded. An excellent report from the Committee on Public Relations, submitted by Mr. H. L. Rice, was then disposed of, after which Mr. H. J. Gonden read a timely and well put together paper on the "Promotion of Friendly Public Relations through Educational Publicity." The discussion of Mr. Gonden's theme was prolonged and worth while. Some of those who participated in the debate were, Messrs. Thurston Owens, Kelsey, Rice and others. At the suggestion of Mr. R. S. Wallace the President appointed Messrs. Eustace, Dickson, McAfee, and Steinwedell as a committee to prepare and present suitable resolutions on the death of the much lamented Mr. J. B. Howard. Mr. A. S. B. Little now read a thoroughly prepared and well worth listening to set of chapters on "Gas Purification." This subject may be ancient and homely but its importance will always be positively in evidence. The compilation was so lengthy that the author only presented an abstract thereof. He was well rewarded by the discussion that ensued. This brought the morning session to a close.

The afternoon session's proceedings were commenced by a report from the Committee on Accidents, read by Mr. L. H. Johnson. This story was really a continuation of the excellent report submitted last year on the same important matter. Having concluded his narration, Mr. Johnson introduced Mr. R. J. Young, Manager of the Department of Safety and Relief, of the Illinois Steel Company, who delivered a most interesting lecture on the practices of his Company in respect to its treatment of matters detailed in the Johnson report. Mr. Youngs' speech was profusely illustrated by lantern slides. This number on the programme would have of itself justified the meeting of the Association. The next paper discussed was that by Mr. F. F. Cauley, the subject of which was "The Possibilities of Gas as an Industrial Fuel." Mr. Cauley told his story well, and its main points were nicely accentuated by lantern slides. An invitation by the American Gas Institute, that the Illinois Association share in the joint preliminary meeting in San Francisco, and to name a delegate to the Gas Congress proposed for 1915, on the Pacific Coast, was then read. Mr. J. M. Morehead, in moving the acceptance of the invitation, cleverly explained the desirability of affirmative action in the premises, and the proposal was enthusiastically sanctioned.—C. H. W.

March 20, A.M.

The thought respecting the banquet last night was sufficiently dynamic or magnetic or impelling to bring together a famous Four Hundred, who strolled in to the beautiful banquet room of the La Salle. Indians of high renown may have in greater degree shared the pleasures of many a gathering under tepees red or otherwise colored, but your scribe imagines that no better time was ever enjoyed than that enjoyed by us in the Red Room last night. The diners started to busy themselves at 7 P.M., and the menu, the service, and the songs were all so good and enjoyable, that it was not until 9 P.M. that that Prince of Toastmasters, Mr. R. C. Dawes, formally introduced the first speaker, Mr. Hodge, who made copious extracts from a speech that would have been made by Mr. H. M. Byllesby, had he not been called out of town. The second number was from the thought of our own Honorable Ira C. Copley. The Congressman, as usual, was the personification of grace, and his make-up could not be excelled—neither could his delivery. Mr. J. M. Morehead also delivered a witty and witful address. At ten the vaudeville was on. Of course, one need not particularize respecting its various numbers,

each one of which, however, evidently gave pleasure to some. It is needless to say that the banquet was enjoyable and enjoyed, from the moment that the Rev. John T. Stone said grace, until the last artist had bowed himself out.—C. H. W.

CHICAGO, March 20, 1913.

The weather this morning was decidedly colder and the sighing of the lake threatened a storm. The attendance this morning numbered well over a hundred, and the final session convened promptly at 10:15, A further report from the Board of Directors recommended the election of six additional new members. Of course, these names were duly added to the rolls, bringing the total membership to the square of 20, minus 4. The proceedings were opened by the reading of an eloquent tribute to the memory of "Uncle Jerry" Howard, which was ordered placed on file. It was determined to instruct the incoming Board of Directors to appoint the delegate to the Gas Congress. The election for officers resulted in the following choices:

President.—Mr. W. F. Barrett, Assistant Engineer, Peoples Co mpany, Chicago.
Vice-President.—Mr. L. H. Johnson, Aurora.
Secretary-Treasurer.—Mr. H. H. Clark, Oak Park.
Delegate to the Gas Congress.—Mr. H. O. Channon, Quincy.
Directors.—Messrs. F. W. Reimers, Rock Island; and F. E. Luther, Chicago.

The new President in accepting the office said it would be his moving purpose to keep up the spirit of enthusiasm that so well marked the progress of the Association from its inception. Vice-President Johnson also agreed to assist in the good work to the best of his ability. At this point a resolution, offered by Mr. H. L. Rice, to the effect that the Secretary be instructed to prepare and forward to each member a bulletin in letter form, to be issued semi-monthly, was carried. This bulletin is intended to furnish a stimulus to bring about greater efficiency in the gas business. The first paper considered was that by Mr. C. E. Reinicker, whose presentation of the subject "Education as a Means to Greater Efficiency in the Gas Industry," was well received. The discussion on this was shared by Messrs. Owens, Schieler and others. Mr. W. F. Yardley then nicely told the delegates "How to Develop an Ideal Complaint Man." If Mr. Yardley's perfect man could be quickly developed he certainly would not long be out of a job. The final paper by Mr. H. L. Farrar, had to do with "A Convenient and Reasonably Accurate Photometrical Standard." Mr. Farrar was kept quite busy for some time after the conclusion of his paper, in answering the many queries propounded. Mr. H. L. Rice took an especially prominent and useful part in the discussion. This terminated the actual technical business of the sessions, and the ending was fittingly marked by a rising vote of thanks to the officers and Committees that arranged for and conducted the proceedings, both technical and social. In this connection I must say that President Channon, who by the way, owes his early training to that great Mentor "Gus." Littleton, of Quincy, is one of the decidedly improving sort, and is sure to be heard from in louder tones later on. Secretary Clark, too, worked like a man who is used to work with a clear end in view. The adjournment occurred shortly after noon, and later special trolley cars will convey the members and their guests to a complete inspection of the Division street magnificent station of the Peoples Gas Light and Coke Company. Of this trip I will make report "in your next."—C. H. W.

BRIEFLY TOLD.

CURRENT MENTION—

MR. W. A. MILLER, who for several years has been the competent General Manager of the Gas Division of the business of the Cincinnati (O.) Gas and Electric Company, has resigned that charge to accept service with the National Chamber Oven Company, of Cincinnati, as Constructing and Operating Engineer. Mr. Miller is recognized as one of the foremost coal gas experts in this country, and the National Chamber Oven Company's management has again demonstrated its clever aggressiveness in securing the services of so valuable a man. Both are to be congratulated over the outcome of the negotiations.

ON the 31st inst., the tax payers of Clarinda (Ia.) will vote on the proposition to grant to Mr. E. A. Murphy and associates, a franchise for the establishment and operating of a gas plant in the named place. Under the terms of the proposed grant, the rates that may be charged are these: For the first 4,000 cubic feet, per month, $1.50 per 1,000; for all in excess of that quantity used per month, $1.35 per 1,000 cubic feet. All quantities are subject to a reduction of 10 cents per 1,000 for prompt payment.

THE Portland (Ore.) Gas and Coke Company, in accordance with the 1911 ordinance, under which it operates, has reported to the City Treasurer gross earnings for 1912 of $1,145,410.02. On this sum the Company is obliged to pay into the City Treasury the sum of 3 per cent.

MR. E. E. RANDOLPH and associates, who were recently granted a franchise to construct and operate a gas plant in Jonesboro (Ark.) declared that construction work will be proceeded with, forthwith.

"R. J. C.," writing from Baltimore, Md., under date of the 15th inst., incloses the following: "Last week a verdict of $1,000 damages was awarded against the Consolidated Gas, Electric Light and Power Company, in part II of the Superior Court, to Mrs. Nellie Bacon. In her Complaint she alleged injuries caused by the violent and boisterous manner in which an agent of the Company entered her home, No. 424 East 26thth street, to turn off the gas supply for non-payment of a bill. On June 20th last, the agent entered the Bacon premises, Mrs. Bacon at the time being ill and in bed. The door was opened by her 11 year old son, and the agent on entering, pushed the boy roughly aside, descended to the cellar, and in disconnecting the meter, created so much tumult and confusion that Mrs. Bacon's illness was greatly increased, even to causing her permanent injury. The Com pany contended that the agent went quietly about his work in the ordinary manner. Of course, an appeal has been lodged."

MR. C. EDMISTON, Superintendent of the Electric Division of the Quincy (Ills.) Gas and Electric Company, has resigned that berth to accept a similar position with the Iowa Railway and Light Company, at its Cedar Rapids division. His successor in Quincy will be Mr. Robert Flanigan, of Springfield.

MR. J. H. SLOAN, of Napoleon O., is proposing to construct and operate a gas plant in Montpelier, O. He offers to furnish gas at a maximum rate of $1.25 per 1,000, on a monthly use of 2,500 cubic feet or less, prompt payment (within 10 days), to entitle the user to a rebate of 10 cents per 1,000. For each additional 2,500 cubic feet per month a reduction of 5 cents per 1,000 from the above named price, becomes effective.

THE Precision Instrument Company, of Detroit, Mich., will furnish the testing apparatus required for the equipment of the Bureau of City Gas and Meter Inspection, recently created in Springfield, Ills.

THE officers elected to manage the affairs of the Hydro Carbon Gas Company, of New Orleans, La., are: President, Wm. Springer; Vice-President, L. W. Leonard; Secretary and Treasurer, Alfred Rose.

"W. W. M." writing from Boston, Mass., under recent date informs us that the Board of Gas and Electric Light Commissioners has authorized the Old Colony Gas Company to issue at par $146,000 first mortgage 5 per cent. bonds, and 2,210 shares of stock, par value $100, making a total of $376,000 of securities, the proceeds of which are to pay off the expenses incurred in construction account in 1912. The officers of the Company are well satisfied with the substantial business developed in the short period of one year since operation began, and with the excellent outlook for securing a large number of additional consumers in the five towns now covered by its mains. Net earnings for the first six months of the present fiscal year, beginning July 1, 1912, are reported over twice interest charges on present outstanding bonds. During 1912 the Gas Company reports having laid 32 miles of mains, bringing its total mileage to 84 and erected a 750,000, cubic foot storage holder to meet the growing needs of its business. Its plant at East Braintree, on Fore river, was completed December 9, when gas was turned on to supply Braintree, Weymouth, Rockland, Abington and Whitman. With its territory only about 25 per cent. developed, it connected over 2,200 consumers last year, which it is expected, will at least be doubled during 1913. E. M. Farsworth & Company, who are financing this enterprise, state that they have purchased the above bonds and will shortly offer them for sale.

WE regret to report the death of Mr. George Ed ward Walsh, for 35 years in the service of the Consolidated Gas Com pany and its predecessors. Mr. Walsh passed away at his home, 105 Gates avenue, Brooklyn, the morning of the 13th inst.

(*Continued from page* 191.)

to this system claiming that it is prohibitively expensive. This is certainly not the case, as is evidenced by the fact that the method is in general use in Europe and in a number of American cities today. The fact is that in many electric railways there is practically no installation of negative feeders, and that the railway companies are often not willing to install even a moderate amount of return feeder copper. A mistake is often made in confusing the radial insulated return feeder system with paralleling the rails with copper. Where the negative bus-bar is connected to the rails at the power station, and these rails are paralleled with copper feeders, the drop in the rails is only reduced in the proportion that the conductivity of the return circuit is increased, but no part of the drop is actually removed from the grounded rails. The amount of copper paralleling the rails that would be required to reduce stray currents to a negligible amount would in all large systems be absolutely prohibitive. This, however, is not the case with the radial insulated return feeder system. With the latter system any desired reduction in rail drop and consequently in the amount of stray current, can be secured, independent of the amount of copper installed, the amount of copper being determined by the allowable drop or power loss in the return circuit. In order to effectively install and maintain an adequate return feeder system that will reduce stray currents on underground piping systems to reasonably small values, it is essential that the pipe-owning companies should co-operate with the railway companies by affording them access to their pipes for making necessary measurements, etc. After a railway company has installed a reasonable and fair return circuit, it sometimes also happens that it is desirable to eliminate any remaining current on pipes by the use of properly located insulating joints. Under these circumstances the pipe-owning companies should be willing to co-operate with the railway company in the installation of such joints.

It is the author's firm conviction that such remedial measures as pipe drainage or insulating pipe joints should be used (if at all) only as a final measure and never until the return circuit of the railway has been improved so that only small amounts of stray current remain on the underground structures.

Discussion.

The President—Gentlemen, you have listened to a splendid lecture on an important scientific subject, delivered in a manner that has made it simple and comprehensible, and by a master mind. I will ask Mr. Gould to open the discussion.

Mr. Gould—Mr. President, our troubles in Boston from electrolysis seem to be disappearing. Looking over our records for the last 4 years, I find we have only had an average of one case of electrolysis on mains and three on services, 1909 to 1912. That means the cases that have been brought to our attention as distinct ones. Of course, we may have had damages to our pipes through corrosion, which did not have the other electrical indications. If you had asked me a month ago whether we had had any trouble, I should have said, "Practically none;" but last month in one of our suburban districts where the electric railroad is not a part of the Boston Elevated System, a service pipe was destroyed. It had been laid about 8 or 9 years. Tests showed that our pipe was an indefinite number of degrees negative to the rails; our voltmeter only registered 10 volts, and the hand came up with a thump on that side of the voltmeter. I have heard since that the engineers from the Metropolitan Water Department 4 or 5 years ago found a maximum of 90 volts in that district, but their pipes being negative to the rail, they did not worry very much about it. This service pipe was within 50 feet of the point where we tested, and was opposite the terminus of the electric road. I found afterwards that a telephone conduit passed under the service pipe at the point where it was destroyed. Undoubtedly the current went from the rails to the main, passed through the service pipe and from it to the telephone conduit, and was one of the best illustrations of that process of destroying pipes. The railroad people are investigating this, and I hope something will be done about it. One of Prof. Ganz's diagrams illustrates a trouble which we were investigating late last fall or early this winter. One of our holders, a steel tank holder, located above the surface of the ground, had a slight leakage through the bottom plates. There is a creek from the river in back of it, formerly salt water, now more or less fresh, on account of the dam of the Charles River Basin. The ground is saturated with marsh water, and, of course, there is salt in it. The power station is perhaps ¼ of a mile above the river. We found that there was a light current passing from the pipes in the governor house to this creek. The quantity of the current we did not know. We simply made a voltmeter test in connection with the railroad officials, and up to the present time nothing else has been done to remedy the trouble. The inserting of insulating joints would be rather difficult at this point. The connecting of the pipes in governor house to plates sunk in the creek by copper wires may do some good. That is all I wish to say, Mr. President, except to express my appreciation of this most excellent lecture by Prof. Ganz.

The President—Mr. Morrison? Dr. Beardsley? Mr. C. J. R. Humphreys, I believe has had considerable experience on this subject?

Mr. C. J. R. Humphreys—I am inclined to think that after Prof. Ganz has finished a lecture on "Electrolysis" there is not very much that the rest of us can add that will be of any very great value. It is true that we did have considerable trouble in Lawrence from electrolysis 4 or 5 years ago, trouble on the sheaths of our underground electric cables and on certain of the gas services, particularly near the power plant. I called Prof. Ganz into our aid, and he made a very thorough survey and very thorough study of all the conditions surrounding us. Some of the slides which have been thrown on the screen here to-day remind me very much of the incidents that we ran against in Lawrence; as, for instance, a current on a water main leading to a building by the water service pipe and then coming in contact with the lead sheath of an electric service, thus getting on our cables in the conduit. Such a case as that takes a good deal of time in tracing out, and I know in one of those cases the Professor had to put in a good deal of time before he found just where the current was getting out to our cable. I do not wish to speak of each particular instance, because I think they are all covered by what the Professor has said. There are certain principles, however, that seem worthy of consideration. When we first took up this matter and we were having considerable trouble with our underground electric cables, the suggestion was made to us by the trolley people that we should connect our sheaths to their return wires to their power house. The Professor and I discussed the matter thoroughly. It seemed as if that were the only remedy, but, after considering the matter, we both agreed on the proposition that we were not going to enter into partnership with the trolley company for the return of their stray currents. They had to take care of their own current; we were not going to enter into any partnership on these lines, and we held to that. Our troubles were lessened a good deal about that time by the fact that the trolley company was relaying its rails in a part of the city where we were having trouble, and we had this matter up with them. We notified them that we expected them to take care of their currents, that we were not going to do it, and in relaying their rails and trackage, they rebuilt on very substantial lines. That lessened our troubles quite a little, and then, of course, the Professor found, as I have just indicated, several cases where the current was coming on to our system, and where it could be done away with entirely or at least reduced. Now, I would like to call attention to the importance of the charts that have been shown or reproduced here, giving the record of the recording instruments, particularly the one which showed the load current for different days in the week and for different hours in the day, where you could see in the evening, as the peak load came on, it was reproduced on the chart, and in the morning and on Sundays. Now, I think that those charts are very important. The professor has used them in Lawrence. Their importance is this, that it establishes without any doubt that it is trolley current. I do not see how you can get away from that. If you study the peculiarities of the trolley system, when the peak comes on and when it goes off, and you find those conditions reproduced on those charts, there is no use of the trolley road coming back and saying, it is not its current. That is what they told us, of course, that it was our own current, not theirs, but with the system of those registering charts, and the study of the peak loads of the trolley system, you can establish that, of course, without a doubt. The only other point I wish to mention, is this: We do not seem to have now very much trouble from stray currents, but we have not stopped and said, "Well, stray currents cannot do us any harm." We have not stopped our investigations. On the contrary, all the work that we have been doing in the past in the way of survey is kept up, and the Professor visits us at least twice a year on a special trip, and during his absence, in the meanwhile, we test our electrical system along the lines which he suggests, the idea being this, and I think an important idea, to catch on to trouble just as soon as it occurs. At times we will, in this way, detect incipient trouble, and while it may not call for immediate action, we know something is going wrong. It cannot do any harm now, but it is something that has to be watched.

Now, having that in mind, detecting what you might call these minor flows of current, we have points that we know will stand watching, and we do watch them, and we hope to catch the source of trouble before any serious damage is done. Electrolysis, I think, is one of those cases where "a stitch in time saves nine" by the systematic survey work carried on practically all the time.

Prof. Ganz—I would like to supplement what Mr. Humphreys has said by a few words. Electrolysis surveys do not always give a direct return for the money spent for them. Mr. Humphreys has brought out exceedingly well how they do serve to keep track of the situation. There is one other very important use of such surveys; namely, when damage results in the future they may be useful as a proof that the damage was caused by electrolysis. Very often after a pipe has been destroyed by electrolysis and has been replaced it is impossible to prove that electrolysis was the cause. Further, if a pipe owning company finds from an electrolysis survey that its piping system is endangered by electrolysis, it can notify the railway company of this fact; if then damage results in the future, the railway company cannot plead that they were not aware of the danger produced by their currents. It has also been my experience that when a railway company knows that the pipe-owning company is making electrolysis surveys, and is keeping watch on the situation, it will do at least some work towards improving the return circuit thus reducing the danger from electrolysis.

The President—Mr. Thayer, I believe you have here a sample of the effect of electrolysis?

Mr. Thayer—I have brought here a piece of an 8-inch water pipe that was taken from under an electric railroad near our plant. The strength of this seems to have all gone except about ⅛th of an inch of the iron. It is very soft. It can be cut with a knife. After the pipe was repaired and the water turned on again, the pipe split, and they had to take out and replace another section. From what I could see it looks as though all along that street there was a good deal of damage being done. The Water Department, I believe, had some tests made on the pipe. What those where I do not know. We have very near that same location two service pipes. One of them runs into the power house and one of them runs along the street right beside the power house. These two lines we have to renew every year or every 2 years at the most.

Prof. Ganz—I would like to call attention to one case where serious damage and serious loss from electrolysis were taking place without becoming known until the pipe was exposed. This was a 4-inch cast iron water service pipe supplying an electric light station situated on a river front, and near an electric railway power station. A change was to be made in the mechanical connections of this water service pipe. When this pipe was exposed it was found that there was a hole almost the size of my fist at the bottom of the pipe, from which water was pouring out into the adjoining river. As no one had suspected this leak it was impossible to judge for how long a period this water had been leaking. An examination showed that the corrosion causing the leak had been caused by electrolysis, and that the pipe generally very badly corroded from electrolysis caused by stray railway currents leaving the pipe in this section. While electrical tests had previously shown current leaving the water piping in this section, no one had suspected the actual serious water leak which was found.

Mr. Humphreys—In our city our electrolytic troubles are spread over the city, as Dr. Ganz has illustrated, but we have more trouble from 1 to 5 miles away from the power house than in the immediate neighborhood. Then one other thing which comes to me in connection with that matter, which is not electrolysis. The city water mains being bonded to the rails, we find that the current goes through our pipes, through the gas water heaters, back to the mains of the Water Department and back to the power station in that way, so that when we make a disconnection of the meters we sometimes get an arc. Of course, when we find that, we remedy it.

The Secretary—I would like to ask Prof. Ganz or anyone else, if in a condition similar to this Charlestown exhibit the chemical composition of the material after it has not been destroyed but changed, can be used as a test to show whether or not the damage has been done by electrolyses or by some other corrosive agency? Most of the cases which I personally have had have been on old lines where there was a possibility of other corrosive agents, and I have asked that question several times without receiving thus far much satisfaction from the answers.

Prof. Ganz—I believe I can give a satisfactory answer, namely, that you cannot tell from the appearance of a corroded wrought iron or steel pipe whether the corrosion and destruction were caused by electrolysis. In the case of cast iron a graphitic material left as the result of the corrosion usually but not always indicates electrolysis. If corrosion from electrolysis is going on, it is perfectly possible, however, to make a suitable electrical test which will show conclusively whether or not stray electric current is leaving the pipe and is causing the corrosion. For this purpose we use an instrument known as an earth ammeter; we place this next to the pipe and connect it to a recording instrument, and obtain a 24-hour record of the current flowing from the pipe to the surrounding soil. This record will not only show the presence of current but will also indicate whether it has railway characteristics. If such current is found leaving the pipe it is certain proof that it must produce a corresponding amount of electrolysis. A test of this kind, together with the corroded pipe, affords in my opinion the best possible evidence that we can have of corrosion by electrolysis. The corroded pipe by itself without any connecting electrical measurements will not ordinarily serve as complete evidence.

Mr. Shattuck—I was interested to hear the Professor say that there was no way of knowing whether a pipe was absolutely damaged by electricity or from some other source. Perhaps in contradiction to that I have heard recently that a Professor in, I think, Swarthmore College, had made examinations under a microscope, and he claimed that in the case of a pipe that was destroyed by electrolysis the particles of iron were magnetic or stood out just as they do around a magnet. I was wondering if the Professor had made any experiments along that line, or if that was more theoretical than it was practical. Has the legal question been touched on?

The President—No, it has not.

Mr. Shattuck—I did not hear the paper. I have been advised quite recently that the proper action to take in cases of electrolysis if your electric company is not willing to go ahead and do something, is to file a bill in equity against a continuing trespass, and you will have a pretty good chance of sustaining an action under such bill. It brings it to a head quicker than anything else, and I believe it is the best legal practice to-day. It may be of interest to some of the smaller companies.

Prof. Ganz—I agree absolutely with the suggestion of Mr. Shattuck. An attempt to secure an injunction would rarely be granted because an electric railway is a public utility, and the courts will hesitate a long while before issuing an injunction restraining them from operating. Regarding the tests suggested by the Swarthmore professor for determining whether a given corrosion was caused by electrolysis or by natural causes, I would like to say that local galvanic action can produce currents which would produce electrolysis in which case the corrosion is not due to external stray electric currents, and yet the corroded iron must have the same appearance as if it had been produced by stray electric current. I, therefore, do not think that much can be hoped for from this test.

Mr. Spear—I would like to ask Prof. Ganz if there is any difference in the relative carrying power of water and gas pipe?

Prof. Ganz—There is no difference due to the fact that the pipes carry water or gas. If you should take an iron pipe and measure its resistance, first when it is empty, and, second, when it is full of ordinary city water, you would not find any difference. It is nevertheless a fact that in practice we usually find that water pipes carry more stray electric currents and are, therefore, more subject to electrolysis than gas pipes. This, I believe, is due to the fact that slight leakage of water at the joints wets the surrounding soil and makes it a better electrolytic conductor, thus causing more current to flow between the surrounding soil and the pipe.

Mr. Spear—What, in your opinion, Professor, would be the least possible voltage to cause electrolysis in a copper tube, for instance?

Prof. Ganz—There is no least voltage. The amount of damage produced by electrolysis depends upon the current and not upon the voltage, except in so far as the voltage determines the amount of current flow.

Mr. Spear—If the telephone wires in a house, for instance, and the house lighting plant, house electrical plant, were attached to the house piping, would it be possible to cause electrolysis there in a slight degree?

Prof. Ganz—Not if I understand the question correctly.

Mr. Spear—Electrolysis must necessarily come in the street?

Prof. Ganz—Electrolysis is only produced where current flows from iron or from a metal to an electrolyte. Ordinary city water is not an electrolyte; for instance, you could not make any measureable current pass through the water in this glass. It is only when

some salt or acid is mixed with water that it becomes an electrolytic conductor.

Mr. Spear—If there was salt in the water drawn through copper tubing, would you then get electrolysis?

Prof. Ganz—I presume that you are referring to the tubes of surface condensers using salt water. I have investigated such cases and have found that the cause of the corrosion of the tubes is local galvanic action and not electrolysis from stray electric currents. In the case of brass condenser tubes this local action results in the solution of the zinc leaving the tube in a brittle form, so that you can easily break it with the hands. I have for example taken a tube containing originally about 40 per cent. of zinc, and have placed this in the salt water discharge from a condenser, and have allowed this salt water to pass through and over the tube for several months. At the end of this period nearly all of the zinc had been dissolved out and the remaining metal had a crystalline structure and was extremely brittle. This was not due to electrolysis from stray electric currents in the sense that we have discussed electrolysis here to-day.

Mr. Spear—Would it be permissible, Mr. President, to go into the matter of heating appliances at this time?

The President—Well, it is 1 o'clock, Mr. Spear, and we have got to reassemble at 2:30 in order to get through our programme this afternoon, and I think we will have to adjourn now.

Mr. Bird—Mr. President, I move that Prof. Ganz be tendered a vote of thanks for his very instructive lecture. [Seconded.]

The President—It is moved and seconded that Prof. Ganz be given a vote of thanks for his very instructive lecture. All in favor please say "Aye," contrary minded. It is a vote.

Prof. Ganz—Mr. President and Gentlemen: I want to express my sincere appreciation for your vote of thanks, and in turn I wish to express my thanks for the evident interest that you have shown in my lecture. [Applause.]

A recess was taken at this point to terminate at 2:30 P.M.

(To be Continued.)

Coal Specifications.

"*Bulletin No. Sixty-Three.*"—We have just received from Washington the information which is undoubtedly true that large users of coal will be interested in Bureau of Mines Bulletin No. 63, on "Sampling of Coal Deliveries, and Types of Government Specifications for the Purchase of Coal," which is now to hand. The Federal Government, which purchases $8,000,000 worth of coal annually, buys more than half of it under specifications and has gone deeply into the question of sampling and analyzing coal. Mr. George S. Pope, the Engineer in charge of such investigations and the author of the Bulletin, makes the following statements:

To determine with utmost accuracy the ash coutent and heating value of a quantity of delivered coal would require the burning of the entire quantity, and special apparatus arranged to measure the total heat liberated, or would require crushing the whole quantity, and reducing it by an elaborate scheme of successive crushings, mixings, and fractional selections to portions weighing approximately 1 gram, the minute quantity which the chemist requires for each determination. Either of these procedures is obviously impracticable, if the coal is to be used for the production of heat and power. The method actually employed is to select portions from all parts of a consignment or delivery of coal, and to systematically reduce the gross sample, obtained by mixing these portions, to quantities that the chemist requires for making ash determinations or that can be burned conveniently in the calorimeter, for determining the heating value. The gross sample should be so large that the chance admixture of pieces of slate, bone coal, pyrites, or other impurities in an otherwise representative sample will affect but slightly the final results. Increasing the size of the gross sample tends toward accuracy, but the possible increase is limited by the cost of collection and reduction. In reducing the gross sample, by successive crushings and halvings or fractional selections, the object is to procure a small laboratory sample that, upon analysis, will give approximately the same results as the gross sample itself, or, in fact, the entire quantity of coal from which the gross sample was obtained.

Recognizing the importance of the method of sampling as being a definite commercial procedure, and of having the method clearly set forth in the specifications to become a part of the contract, and recognizing also the desirability of insuring uniformity and similarity in the specifications used by the different branches of the Federal service for the purchase of coal, representatives of the executive departments and independent establishments of the Government held a conference under the auspices of the Bureau of Mines in February, 1912, for the purpose of discussing these and other features of the specifications. At this conference committees were appointed to prepare specifications in accordance with the views of the members. It was recognized at the conference that, in general specifications, such as were recommended, certain requirements had to be of wide application, as the specifications cover such a wide variety of conditions, not only as to character and quality of coal, but as to type of furnace equipment, size of deliveries, methods of delivering, etc.

The specifications which were used for the purpose of coal on the heat-unit basis, prior to the fiscal year 1912-13, were on the British thermal unit "as received" basis; that is, payment for delivered coal was directly affected by the moisture content of the sample received by the laboratory. This method was based on the assumption that the moisture in the samples collected at the time of weighing and delivery could be preserved with slight loss during the storing and subsequent working down of the gross sample to a quantity convenient for transmittal to the laboratory and in its later treatment in the latter. From experiments that have been made, and from a large mass of data, it is known that the moisture content of coal does not remain constant, and that the moisture content reported by the laboratory may be as much a 5 to 10 per cent. lower than that actually contained in excessively wet or high moisture coal at the time of weighing.

* * * As a sample loses moisture, its B. T. U. "as received" value correspondingly rises, with the result that the price for delivered coal determined on the "as received" value is, with rare exceptions, higher than that warranted by the quality of the coal at the time of weighing. As a general statement, payment based on the "as received" B. T. U. value will be higher than warranted, unless the sampling and laboratory work can be carried on under conditions that minimize moisture loss, as under freezing temperatures.

Recognizing the uncertainty involved in taking the moisture determination in the laboratory as representative of the moisture content of the delivered coal and the consequent possibility of payment of a higher price than is warranted, the Bureau of Mines recommended to the executive departments and independent establishments of the Federal service that the heating value in the coal specifications for the fiscal year 1912-13 be on the "dry coal" basis.

In preparing these specifications the fact was recognized that the amount of moisture contained in coal produced from day to day from the same mine, or group of mines working the same bed, is largely accidental, and is a matter over which the buyer and seller have only slight control. However, in order to place a negative value on high moisture coals, and to protect the Government against the delivery of coals containing excessive amounts of moisture, the specifications require the bidders to specify the maximum moisture content in coal offered. This value becomes the standard of the contract.

If coal of uniform B.T.U. "dry coal" value is delivered on a contract, the contractor receives the advantage on any delivery in which the moisture content approaches the maximum specified, because he is paid for the weight of water contained in the coal in excess of a normal amount, whereas if the coal is very dry, containing less than the normal amount of moisture, the purchaser receives the advantage.

* * * As an example of the effect of a heavy rain on a car of coal in transit, a precipitation of 3 inches of water on a loaded 50-ton car, area of top about 360 square feet, would increase the weight of the coal 5 01 per cent., providing none of the water drained out or evaporated. It is obvious that if this coal is weighed and delivered immediately, special samples for moisture determinations should be collected and prepared at once and sent to the laboratory, as a basis for equitable adjustment of payment on account of the excessive amount of water in the coal. As the weight of the coal was increased by the excess water, there should be a corresponding decrease in the price to be paid.

If a railroad car or wagon so rained on should not be unloaded immediately after weighing, and special moisture samples should not be properly collected, prepared, and sent hermetically sealed to the laboratory, it is obvious that the purchaser would pay a higher price than warranted, especially if the car or wagon stood for some time before sampling and some of the water drained out. Further, if the coal was not immediately unloaded and sampled, or if the car continued in transit after weighing, then the coal at the top would

soon dry; and in either case the effect of the 3-inch rainfall, as indicated by the analysis, might be only a fractional percentage of the moisture contained in the coal at the time of weighing.

The determination of the moisture of coal delivered from stock piles is often of great importance, for the proportion of moisture contained in the small sizes, which are most abundant near the center of a stock pile and which absorb the rains, and melting snows in districts of heavy snows, may be from 10 to 15 per cent. higher than when stocked. It is apparent, therefore, that special moisture sample determinations are necessary for equitable adjustment of payment on amount of excessive moisture in coal which is stocked in piles exposed to the weather.

The specifications provide for the collection of "special moisture samples" if, in the opinion of the Government officials sampling it, the delivery contains moisture in excess of that guaranteed by the contractor. The "special moisture samples" are prepared in a manner to minimize moisture losses and may be taken and prepared independently of the gross samples collected for the determinations of heating value (B. T. U.), ash, and other specified data. If the analysis of the special sample shows a moisture content in excess of the contractor's guaranty, a proportionate deduction is made from the price to be paid for the coal. Copies of this "Bulletin" may be obtained by addressing the Director, Bureau of Mines, Washington, D. C.

New Methods and Appliances.

ADVERTISING IN ITS BROADEST SENSE.—In an interesting paper, entitled "Advertising in Its Broadest Sense," read recently by Mr. Thomas Elcock, Jr., Advertising Manager, United Gas Improvement Company, Philadelphia, before a well-attended meeting of the New England Section, N. C. G. A., the author said:

Even so recently as 5 or 6 years ago this subject would have been only superficially understood by many of us; most of us, in fact, would have had no definite idea of what advertising meant to a public utility company; how it could be done and what it would accomplish. But conditions have undergone a quick and broad change within these few years. The gas industry need bow to no class of business in its progression in advertising, and to-day the gas company that does not advertise, and using all the means at its disposal for publicity and for supplementing by advertising its other efforts for new business, is standing still with imminent danger of a quick retrogression. Let us be introspective. Let us think seriously if we are doing all we possibly can to foster at all times the goodwill of our public.

You can create in one night a bad opinion about a corporation of which the public knows nothing; but when the public has already a good opinion, to transform it into a bad opinion is another matter. In this age of agitation through which we are passing, the public utility company is indeed fortunate that escapes the villification of the yellow press. We need have no fear of criticism of this description, but we must truly fear the criticism of the honest newspaper (which, thank God! predominates in number and influence in every city), which forms its criticism from a pardonable ignorance born of the reticence on the part of the company criticised to give to the public facts in regard to its business which would be of actual interest, in fact, what the public has practically a right to know.

By honest publicity, by being frank and open with your public, by not attempting to keep secret any fact that in itself is no secret at all, we *give* our company a voice, even *make* it a characteristic part of our city. By fair dealings, frank publicity and honest service, why is it not possible for our public to have absolute confidence in everything we say?

Publicity will lead us a long way towards this goal; service, modern merchandising, and progressive methods generally, will take us the rest of the way.

It seems to me that the primary phase of our problem lies within two big words (regular Boston words) "*interdepartmental co operation.*" Without this pulling together we will make little or no progress. We must kill, quickly and forever, all petty jealousies existing between the new business department, the commercial department, the distribution department and the manufacturing department. The little hammer knocks and annoys, but frequently it grows to a sledge, and then it hurts.

Again, citing the advertising man and the engineer. Let the former go to the latter, let him have the engineer explain why days are taken in tests and research that have appeared to the advertising man as days wasted in useless technique, let the engineer show that these efforts have resulted in a better retort, better gas that will mean thousands of dollars saved yearly in manufacturing. Let the engineer confer with the advertising man and be shown that he is not inexact, that he has studied the manifold problems of selling, and that judicious advertising is just as important to-day to the gas industry as it is to the department store.

The so-called committee system is a great aid to co-operation. By it the heads of the various departments are brought together at specified times, say once a week, to confer on the matters that concern them in common. This gives an opportunity for each department to express its views and to learn the opinions of others who are equally interested in the matters under discussion. It will tend, I think, to an elimination of the narrow departmental view in any matter and to think more of the interest of the business as a whole. Criticism is due frequently to the failure of one department manager to get the point of view of another, to know his problems and to look at the business from the standpoint of his position. If the two department heads can be brought together to frankly consider the various aspects of any question on which they may hold different opinions they are very likely to alter their different attitudes and to reach a conclusion that is satisfactory to both. It seems to me that these meetings should be made compulsory and should be of frequent occurrence.

An organization is just like a great, big, intricate piece of machinery. When all parts are working together the machine runs with a purr, smooth, quiet and highly efficient. Let any part work against another, let it heat up, hold back and try to throw the load on another part and you have the whole mechanism out of kilter, and efficiency falls by the board.

If there is a Rotary Club in your city where the live wires of every merchandizing organization meet, by all means join it. Have your advertising man join the "Ad. Club," and all of you get together every now and then to discuss what you have learned from the other merchants in your city, and I think you will be surprised over the number of good ideas you can adapt to our business. Should you study the methods of a department store I am sure it will open your eyes to some extent in regard to service. In such a store the primary endeavor is to please the customer. They go a long way frequently to avoid complaints. They lose on sales rather than lose the customer. You will also learn from them of the particular effort they make on deliveries, and while they maintain to some extent a certain time schedule they are very willing at any time to break this schedule to put through a rush order.

Salesmanship in our industry is true salesmanship. It embodies all the necessary points of approach, attracting attention, arousing interest, creating desire, inducing resolution, inciting to action and the final closing of the sale.

Just a word now in regard to the training of salesmen. It is, of course, necessary that they should be thoroughly instructed in the various forms and policies of the company, but I wish to emphasize the importance of a practical training. I doubt if it is proper for us to place the salesman at the mercies of the public until he has been trained for a period of at least 1 month, 2 weeks of which should be spent in the repair and distribution shops, and out on actual complaint work on appliances. Training such as this is the most thorough and far-reaching in its results.

A very small part of the present agitation against corporations is based on actual corporate abuses, and much of it arises from a vague distrust due to the secrecy with which many corporations conduct their affairs. The public feels that they are working in the dark in some mysterious way to accomplish unknown ends. This engenders an enmity toward all corporations, whether good or bad, and people in this frame of mind take careful note of every defect in service rendered by a corporation, however slight and temporary it may be, and it is interpreted as another sign of corporate greed and lack of care for the interests of the public. A corporation need be no more unpopular than it wants to be. If it wants to make friends it can, and I think you will agree with me that the surest, most lasting way to accomplish this desired end is by making every attempt we possibly can to give the best, the most cheerful and the most interested service; to come out of our shells; to let people know why we do things and why we must do things; by a campaign of honest publicity. Buying newspaper space and printed matter will possibly sell your goods, but back these up by the popularity of the corporation and your advertising will repay you a thousand fold.

THE DETROIT CITY GAS COMPANY'S COACHING RESPECTING THE USE OF THE TELEPHONE.

1. When you answer a telephone always give your department and your name. It saves the consumer's time and he knows how to get you again if perchance he gets cut off. By giving the consumer your name you stimulate his confidence in the Company, because he realizes that he is talking to a person instead of "just a clerk."

2. Out of necessity the consumer must give his name and address, and it is important that you be as careful as possible in getting this the first time he speaks it, as it is annoying to have to ask him to repeat his name and street number too often.

3. Repeat his or her name as often as convenient while holding conversation. Speak your own name if occasion arises, so that the conversation may be made more personal.

4. Get the consumer's telephone number.

5. Ask the consumer to call you personally if the complaint or the request is not taken care of promptly.

6. Make it apparent that you are giving the consumer personal attention. It takes less time to give him all the time he needs over the telephone and thus get his request clearly before the proper department than it does to have him repeat the call at various times, on account of not obtaining full information the first time.

7. In main, answer all requests with "Yes," and make your exceptions and qualifications afterwards.

8. Deem it a privilege to see that the request gets proper attention.

9. Talk from the consumer's standpoint.

10. In finishing a conversation always thank the consumer for having had the opportunty to attend to his request. Thank him by name, and be sure to give him your name and your department, so that he can get you again if the request does not get proper attention.

11. In referring a customer to another department be particular to give the name of the person in the department to whom he is to talk. Be sure to get the full request of the consumer before referring him to another department, to avoid the error in referring him to the wrong department.

12. Remember that the consumers who call us by telephone get their impression of the gas company from the way that you talk to them, and that we want you to help make this impression a good one

Pretty good work, this, Mr. E wing. In fact it looks so good to us that a reprint thereof would be a useful thing to have close to the telephone of any public service corporation.

Items of Interest
FROM VARIOUS LOCALITIES.

"F. W. S.," writing under recent date, notes "That on the evening of the 6th inst., the regular meeting night of the Public Service Commercial Association at Jersey City, N. J., a ladies' session was the feature. The regular business was dispensed with by substituting an excellent vaudeville entertainment for the amusement of the members, their wives and friends. This, the first ladies' night arranged by the Association, was largely attended, the Jersey City Auditorium being crowded beyond its capacity. The excellent professional talent engaged by the Entertainment Committee afforded an abundance of pleasing numbers, bringing out many new stories and songs. A series of moving pictures added zest to the entertainment. A notable feature of the evening was a series of violin selections rendered by Miss Harris, a protege of Mr. Walter Damrosch the famous conductor. Her rendition was excellent and the appreciation of her hearers was evidenced by their demands for repetitions. Refreshments were served by a prominent caterer and the affair was in every sense a decided success. Complimentary remarks heard during and after the session make it quite probable that ladies' nights hereafter will be regular features of the Association's assemblings."

EARLY this month there was formed, in the city of La Crosse, Wisconsin, a new organization to be known as the "La Crosse Gas and Electric Association," the first meeting being held in the offices of The La Crosse Gas and Electric Company. The Association is composed of all the employees of the Company and its purposes are educational and social. Monthly meetings will be held at which addresses will be made by men prominent in the industry, and papers for provoking discussion read by members. It is also on the cards to form a Base Ball Club. At the initial meeting Dr. D. J. Eagan, the Company's Physician, delivered an address on "First Aid to the Injured." He clearly explained the remedies that should be used in accident cases and methods of treatment. He also demonstrated how best to accomplish resuscitation. After refreshments had been served Mr. James Litster sang some typical Scotch ballads and the evening's entertainment was brought to a close. The following officers were elected: President, Mr. Thurston Owens; Vice-President, Mr. Thos. Bramwell; Secretary, Mr. P. R. Linter; Treasurer, Mr. J. M. La Vaque; Directors, Miss Bessie Deneen, Mr. Oscar Schumacher, and Mr. Joseph Smith.

THE New England section of "The Gas Meeters" held its second dinner the evening of the 11th inst., covers being laid in the dining room of the New American House in Boston. There was a large attendance especially of the new members. An excellent musical programme was rendered and a slight of-hand performance, by Mr. Howard Morse, of the Pittsburgh Water Heater Company, was well received. Mr. Morse is a past-master in the art of the magician and an adept at card tricks. An interesting address was given by "Governor" Hayward, of the Connelly Iron Sponge and Governor Company. Mr. E. R. Locke, of Arlington, Mass., proved again his capacity as a good story teller, as also did Mr. F. D. Cadwallader, of Lowell, and Mr. B. W. Dole, of Newark, New Jersey. Others who acquitted themselves ably in this same line were Mr. W. R. Spear, of the Beler Water Heater Company, Mr. R. M Tompson, of the Welsbach Company, Mr. Frank Jennings, of South Framingham, and Mr. H. H. Field, of Haverhill. This meeting well developed the fact that the membership of The Gas Meeters holds plenty of good talent and that they need not go outside their own members for entertainment.—W.

"A. E. S.," writing from Lafayette, Indiana, under date of the 14th inst., says: "Mr. Samuel T. Murdock, Managing Director of the Indiana Lighting Company, entertained the Lafayette employees of the Corporation at a six o'clock dinner the evening of March 9th, at the Lafayette Club, in honor of Mr. William Wallace, the Superintendent of the Lafayette gas plant, it being the 45th anniversay of Mr. Wallace's connection with the gas industry in Lafayette. An elaborate 5 course menu was served and covers were laid for 92. All the employees were present excepting the night force of coal gas stokers, the water gas plant having been shut down to enable the men to attend the function. Dinner was sent to the absent stokers so that not a single local employee missed the excellent repast. The dining-room was profusely decorated with carnations and ferns, the guest of honor's place being marked by a large cluster of the former. Red carnations were given as favors. The affair was a complete surprise to Mr. Wallace, the guests being seated in the spacious dining-room of the Club when he was ushered in, having been called by Mr. Murdock on the pretense of a business engagement. The event was a very happy one, and all heartily entered into the spirit of the occasion. A delightful musical programme was rendered by Reifers' Orchestra. At the conclusion of the dinner, the guest of honor was presented with a silver loving cup, carrying the following inscription:

"1868
to
William Wallace
With pleasant memories
from
His co-workers in the Gas Industry
Lafayette, Indiana.
1913."

The presentation was made by Mr. Murdock and Mr. Wallace graciously acknowledged the gift and compliment in a few well chosen words. Mr. Wallace is probably the oldest gas man in this part of the country, both in point of years and service. He is one of the five who signed the original call for the formation of the Western Gas Association. At the close of the dinner a flashlight photograph was taken of the party and the picture will be presented to each employee as a souvenir of the occasion."

THE J. G. White Corporation, 43 Exchange Place, New York, announces that Mr. Joseph K. Choate has become a member of its New York staff and has been elected a Vice President of the Corporation.

Mr. E. V. Anderson, Engineer in charge of the gas division of the properties of the Central Hudson Gas and Electric Company, sailed for England the 22nd ult. His time abroad will be devoted to the investigation of vertical retort systems. He will also make a general survey of current English practice in gas making. He will return early this summer.

"C. T. J.," writing from Springfield, Mass., under recent date, has declared The Springfield Gas Light Company not guilty on all the charges regarding the destruction of shade trees by gas poisoning, in the first criminal case of this nature to be tried in Massachusetts. In announcing his decision Judge Lyford declared that under the statutes it must be shown and proved that the Company wantonly and negligently injured the trees. He disagreed with the Commonwealth in its contention that the trees died from the effects of escaping gas was *prima facie* evidence to prove negligence beyond a reasonable doubt; and in fact did not know there was any way to prove criminal negligence in such instances under the present law. He added that it had been proved beyond a reasonable doubt that the Company had caused the injury to the trees, but that as negligence was not proved, he would find the defendant not guilty. In bringing the case the City Forrester, Mr. W. F. Gale held that the killing of the trees would have been prevented if the Company's pipes had been laid below the frost line and if adequate inspection for the detecting of such leaks had been provided. The Company held that no adequate method of inspection could be arranged. Further it was impossible to determine a safe covering depth for mains that would be applicable during our varying winters. For instance he called attention to the great disparity that existed between the winter of 1911-12, and that of 1912 13, making the further point that to have buried the mains at a point below the frost line average of the frost named period would have made it almost impossible to supply gas to the people at anything like a reasonable cost. The main injuries to the Springfield trees were occasioned during the winter of 1911-12. For the chief facts in this story we are indebted to the courtesy of Mr. F. L. Belcher.

The American Public Utilities Company, which is controlled by that sterling firm, Kelsey, Brewer & Co., shows an increase of gross earnings during last month equal to 16.2 per cent. The net earnings from operation for the same month show a gain of 35.9 per cent. and for the five months the respective percentage gains are respectively 13 3 and 15.0

Here is richn ess! The authorities of Jefferson County, Ky., have filed suit against the Kentucky Heating Company and the Kentucky Fuel Gas Company for $2,750, alleging the destruction of a steam roller owned by the County. The charge is that the roller was wrecked, September 30th last by an explosion of gas that occurred on the 18th Street Road near Chesterfield Station when it came in contact with and severed an 8-inch gas main. To "further strengthen" the allegement the petition declares that the escaping gas was ignited by the fire on the grates under the boiler of the roller.

Mr A. C. Harrington, who has succeeded Mr. W. J. McCorkendale as Manager of the Marquette County (Mich.) Gas and Electric Company, is now in active harness. One of his latest achievements was the designing and constructing of a 10,000 horse power plant at Ogden, Utah.

At the annual meeting of the shareholders in the Joplin (Mo.) Gas Company the following officers were re-elected: President, Mr. James T. Lynn; Vice-President, Mr. W. A. Campbell; Treasurer, Mr. A. L. Wilkinson; and Secretary, Mr. V. N. Gurney. The Company's affairs are in very satisfactory condition.

At the annual meeting of the Macon (Ga.) Gas Company the officers elected were: Directors, Messrs. W. H. Felton, J. C. Campbell, H. T. Powell, T. F. Wickham, P. G. Gossler, and A. R. Willingham.

The New Jersey State Board of Public Utilities has assented to the petition of the Atlantic Highlands Gas Company for permission to lay its mains along the Mott Street Bridge, between Keyport and Matawan.

"Madison," writing under date of the 11th inst., has this to say: "The Madison, New Jersey Council met Monday evening to discuss the matter of electric lighting rates—the Madison electric plant is operated municipally. The users of current are anxious for the reduction, urging that the streets and public buildings are lighted without expense to the general community, but in reality they are paid for out of the general treasury receipts and so do not come from those who use no current and yet get the benefits of the street lighting- Those in opposition to the plan urge that the earnings should be applied to paying off the bonds issued for the plant.

The Slatington (Penn.) Gas Company is making a great display of gas appliances in the show window of the Neyer Building.

Mr. Rueben H. Barber has resigned the position of Chief Engineer of the Holyoke (Mass.) Municipal Lighting Plant, to enter the service of the New Bedford Gas and Edison Light Company.

Superintendent H. S. Shaw, of the Webster and South Bridge (Mass.) Gas and Electric Company, has announced a new selling rate for electric current. It is 14 cents per kilowatt hour, less 10 per cent. for prompt payment.

The many friends of Miss Edith Black of the offi ce force, of the Fitchburg (Mass.) Gas Company, will be glad to know that she is rapidly convalesing from her recent severe illness.

At the annual meeting of the shareholders in the United Gas and Electric Corporation, held at No. 11 Central Row, Hartford, Conn., re-elected the following directors: Messrs. S. R. Bertron, R. E. Griscom, George Bullock, Henry Morgan, F. M. Potts, John S. Jenks, Jr., Samuel Insull, John Gribbel, W. W. Griest, M. W. Dodge, R. L. Montgomery, G. E. Shaw, Harry Bronner and S. C. Dunham.

The evening of March 12th twenty-five members of the Commercial Club, of the Boston Gas Company, gave a dinner in Banquet Hall, of the Quincy House, to Mr. A. H. Vegkley, recently resigned as Manager of the Commercial Department of the Company. The toastmaster, Mr. George T. Hartford, on behalf of the members, presented the guest of the evening with a beautiful watch chain.

Mr. Mathew Lahti, Assistant Cashier of the Fitchburg (Mass.) Gas and Electric Company, has been tra nsferred to the executive offices of the Chas. H. Tenney Company.

The contract for the rebuilding of the Perry (Ia.) works has been let. The plant which was recently destroyed by fire will be reconstructed on a larger scale. The main system will be increased by an addition thereto of 4 miles of pipe.

Recent Patent Issues.

Prepared for the American Gas Light Journal by Royal E. Burnham, solicitor of patents and counselor in patent causes, 833 Bond Building, Washington, D. C., from whom illustrations and specifications of any patent mentioned below may be obtained for 20 cents.

1,055,317. Means for the Manufacture of Carbureted Water Gas. L. D. Carroll, Westminster, England, assignor to A. G. Glasgow, Richmond, Va., and Westminster, England.

1,055,334. Process of Makin g Gas. W. G. Laird, Washington, D. C., assignor to The Improved Equip ment Company, New York City.

1,055,342. Incandescent Gas Lamp. P. Lucas, Sudende, Germany.

1,055,363. Water Heater. L. P. Silverman. Provid ence, R. I.

1,055,420. Gas Analyzing Apparatus. L. Sanders, New York City, assignor to Sarco Fuel Saving and Engineering Company.

1,055,422. Gas Fixture Attachment. J. Scott, Milwaukee, Wis.

1,055,536. Retort Coke Oven. C. H. Hughes, Syracuse, N. Y., assignor to Semet-Solvey Company.

1,055,549. Mechanism for Separating Gas from Liquids. G. L. McIntosh, Los Angeles, Cal., assig nor of two-thirds to K. L. Byrne and R. C. Olmsted, Pasadena, Cal.

1,055,657. Gas System. A. C. Roessler, Mineola, and W. A. Armington, New York City, assignors to Bay State Gas Company.

1,055,792. Dry Gas-Cleaner. A. F. Plock, Pittsburgh, Pa.

1,055,803. Gas Cut Off. A. Runnion, Spencer, W. Va., assignor to O. J. Chambers and L. S. Goff.

1,053,837. Means for Heating Vertical Gas Retorts. H. J. Toogood, Elland, England, assignor to R. Dempster & Sons.

The Market for Gas Securities.

There was no market for gas securities last week, neither was there any material change in values for Consolidated, the high of which for the week was 130½, the low 129½, and the closing (last Thursday) 130. The Company's business continues good. Brooklyn Union sold at 130 and at the close the quotation for it was 127–130.

As it was with the city shares, so was it with outside securities. Peoples of Chicago, at the close of trading on Thursday, was 109½–110. Lacledes were dull and the same may be said of the Massachusetts Gas securities. The quarterly dividend of one per cent. on the common of the latter is payable May first.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

115 BROADWAY, NEW YORK CITY.

MARCH 24.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked*
Consolidated Gas Co.	$99,816,500	100	130¼	132
Central Union Gas Co.—				
1st 5's, due 1927, J. & J.	8 5 0,000	1,000	103	105
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	105	106
Mutual Gas Co.	3,600,000	100	172	177
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	101	102½
New York & Richmond Gas				
Co. (Staten Island)	1,500,000	100	59	62
1st Mtg. Gold Bds. 5 p. ct.	1,500,000	—	98½	100½
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	103	105
Con. 5's, due 1945, J. & J.	1,500,000	—	98	100
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	99½	101
Standard	5,000,000	100	60	70
Preferred	5,000,000	100	90	100
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	103	105
The Brooklyn Union	15,000,000	1,000	127	130
1st Con. 5's, due 1948, M. & N.	15,000,000	—	106¾	107
Yonkers	299,650	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	¼	5-16
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	—
" 1st Mtg. 5's	500,000	1,000	97	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	59	60
Capital, Sacramento	500,000	50	—	85
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed				
Gold Bonds	7,660,000	1,000	104	106¼
Cincinnati Gas and Electric				
Co.	29,500,000	100	87	90
Columbus (O.) Gas Co., 1st				
Mortgage Bonds	1,500,000	1,000	96	98
Columbus (O.) Gas Lt. &				
Heating Co.	1,882,750	100	90¼	91
Preferred	3,026,500	100	75¼	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	13,460,084		118¾	119
Mortgages, 5's	3,400,000		—	—
General Mortgage 4½	10,661,000		—	—
Con. Gas Co., Baltimore				
City, 4½	2,751,000		—	—
Consolidated Gas Co. of N. J.	1,000,000	100	15	—
Con. Mtg. 5's	976,000	1,000	94	96
Bonds	75,000	—	—	100
Detroit City Gas Co.	6,580,000	—	—	50
Detroit Gas Co., 5's	381,000	1,000	75	90
" Prior Lien 5's	5,619,000	1,000	97	100¼
Equitable Gas & Fuel Co.,				
Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	133	136
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co.,				
1st Mtg. 5's	1,350,000	1,000	100	101
Hartford	750,000	25	190	200
Hudson County Gas Co., of				
New Jersey	10,500,000	—	130	133
" Bonds, 5's	10,500,000	—	101	106
Indianapolis	2,000,000	—	38	45
" Bonds, 5's	2,650,000	—	104¼	106
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	91	
Kansas City Gas Light Co.,				
of Missouri	5,000,000	100	—	86
Bonds, 1st 5's	3,822,000	1,000	98½	99
Laclede Gas Co., St. Louis.	10,000,000	100	100	100½
Preferred	2,500,000	100	99	102
Bonds	10,000,000	1,000	102¾	103
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	120	120
Madison Gas and Electric Co.				
" 1st Mtg. 6's	400,000	1,000	106	
Massachusetts Gas Compan-				
ies, of Boston	25,000,000	100	88	88½
Preferred	25,000,000	100	93¼	94
Montreal L. H. & P., Canada	9,000,000	100	235½	236
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	97	98
Bonds, 6's	6,000,000	—	127	128
New Haven Gas Co.	5,000,000	25	189	190
Peoples Gas Lt. & Coke Co.,				
Chicago	25,000,000	100	109½	110
1st Mortgage	20,100,000	1,000	102	102½
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104¾	105¼
Pacific Gas and Electric Co.	15,500,000	—	58½	60
St. Joseph Gas Co.—				
1st Mtg. 5's	1,000,000	1,000	94	98
St. Paul Gas Light Co.	2,500,000	100	—	—
1st Mortgages, 6's	650,000	1,000	104	105
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	3,447,000	1,000	94	96
Syracuse Gas Co., N. Y	1,975,000	100	50	55
Bonds	2,047,000	1,000	101	103
Washington (D. C.) Gas Co.	1,600,000	200	427½	428
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	—	—

MEETING TIMES OF THE VARIOUS GAS ASSOCIATIONS.

American Gas Institute.—Annual meeting, Richmond, Va., October 15-17, 1913. Officers: President, W. R. Addicks, New York City. Secretary, Geo. G. Ramsdell, 29 West 39th st., N. Y. City.

Canadian Gas Association.—Annual meeting Sept. 1913. Officers: President, Arthur Hewitt, Toronto, Ont.; Secretary and Treasurer, John Keilor, Hamilton, Ont.

Empire State Gas and Electric Association.—Annual meeting, New York City, Oct. 8, 1913. Officers: President, C. G. M. Thomas, Long Island City, N. Y.; Secretary, C. H. B. Chapin, 29 W. 39th street. New York City.

Gas Meters.—Monthly Section Meetings; Grand Commissioner, I. W. Petty, New York; Gen'l Sec'y, H. Thurston Owens, La Crosse, Wis.; New York Section, Chairman, Will W. Barnes; Secretary, A. M. Berg, Sip ave., Jersey City, N. J. Philadelphia Section; Chairman, L. R. Dutton; Secretary, H. F. Patterson, Jr., 833 Chestnut street. Cleveland Section, Chairman, F. R. Hutchinson; Secretary, Wm. Holtz East Ohio Gas Co. New England Section, Chairman, F. M. Roberts, Haverhill; Sec., F. K. Wells, 60 Broad street, Boston.

Guild of Gas Managers of New England.—Annual meeting, March, 1913. Young's Hotel, Boston; monthly meeting, second Saturday. Officers: President, Walter G. Africa, Manchester, N. H.; Secretary, H. K. Morrison, Brockton, Mass.

Illinois Gas Association.—Annual meeting, March 19th and 20th, 1913. Chicago, Ills. Officers: President. H. O. Channon, Quincy, Ills.; Secretary-Treasurer, Horace H. Clark, 115 No. Oak Park avenue, Oak Park, Ills.

Illuminating Engineering Society.—Annual meeting,———— September, 1913. Meetings of Sections, monthly. Pres., Preston S. Millar; General Secretary, J. D. Israel, 29 W. 39th street, New York City. Sections: New York, Secretary, C. L. Law, 124 West 42d street. New England, Secretary, H. C. Jones, 10 High street, Boston, Mass. Philadelphia, Secretary, L. B. Eichengreen, Broad and Arch streets. Chicago, Secretary, J. B. Jackson, 28 North Market street. Pittsburgh, Secretary, J. C. Mundo, Oliver Building.

Indiana Gas Association.—Annual meeting, March 12 and 13, 1914. Terre Haute. Officers: President, A. S. Cooke, Terre Haute; Vice-President, A. C. Blinn, Evansville; Secretary-Treasurer, Philmer Eves, Indianapolis.

Iowa District Gas Association.—Annual meeting, May 22, 23, 24, 1913; Burlington, Ia. Officers: President, C. W. Fair, Atlantic, Ia.; Secretary, G. I. Vincent, Des Moines, Ia.

Kansas Gas, Water and Electric Light Association.—Annual meeting, October——1913. ———— Officers: President, L. O. Ripley, Emporia, Kas.; Secretary and Treasurer, W. H. Fellows, Leavenworth, Kas.

Michigan Gas Association.—Annual meeting, September——1913; ———— Officers: President, W. S. Blauvelt, Detroit, Mic; Secretary-Treasurer, Glenn B. Chamberlain, Grand Rapids, Mich.

Missouri Electric Light, Gas, Water Works and Street Railway Association.—Annual meeting, April, 1913; Mexico, Mo. Officers: President, P. A. Bertrand, Joplin, Mo.; Secretary and Treasurer, P. W. Markham, Brookfield, Mo.

National Commercial Gas Association.—Annual meeting and gas show, Dec. 1-6, 1913. Philadelphia, Pa. Officers: President, C. W. Hare, Philadelphia Pa.; Secretary, Louis Stotz, 29 West 39th street, New York City.

Natural Gas Association.—Annual meeting, Cleveland, O., May 20 22, 1913; Officers: President, M. B. Daly, Cleveland, O; Secretary, T. C. Jones, Delaware, O.

New England Gas Association.—Annual meeting, February, 18th and 19th, 1914 Boston. Officers: President, T. H. Hintze, Providence, R. I.; Secretary-Treasurer, N. W. Gifford, East Boston, Mass.

New Jersey State Gas Association.—Annual Meeting April —, 1913, ———— N. J.—President, William H. Pettes, Newark, N. J.; Secretary-Treasurer, Arthur H. Osborn Belmar, N. J.

Ohio Gas Association.—Annual meeting, February ————, 1913, Columbus, O.; President, John M. Garard, Columbus, O.; Secretary, L. B. Denning, Columbus, O.

Oklahoma Gas, Electric and Railway Association.—Annual meeting, Oklahoma City May, ——1913. President, F. W. Caldwell, Shawnee, Okla.; Secretary, H. V. Bozell, Norman, Okla.

Pacific Coast Gas Association.—Annual meeting, San Jose, Cal., September 16, 17, 18, 1913. Officers: President, Henry E. Adams, Stockton, Cal.; Secretary-Treasurer, Henry B stwick, 445 Sutter street, San Francisco, Cal.

Pennsylvania Gas Association.—Annual meeting, York, Pa., April 9-11, 1913; Officers, President, H. H. Ganser, Norristown, Pa.; Secretary-Treasurer. W. O. Lamson, Jr., West Chester, Pa.

Society of Gas Lighting.—Annual meeting Dec., 11, 1913; monthly meetings, second Thursday. Place, New York City. Officers: President, Fred. S. Benson; Secretary, George G. Ramsdell, 29 West 39th street, New York city

Southern Gas Association.—Annual meeting, Charlotte, N. C., April 18-20, 1913, Officers: President, C. E. White, Montgomery, Ala.; Secretary-Treasurer, E. D. Brewer, Atlanta, Ga.

Southwestern Electrical and Gas Association.—Annual meeting. May 21, 22, 23 and 24, 1913, Galveston, Tex. Officers: President, F. M. Lege, Jr., Galveston, Tex.; Secretary H. S. Cooper, 405 Slaughter Bldg., Dallas, Tex.

Wisconsin Gas Association.—Annual meeting, May 14 and 15, 1913, Milwaukee, Wis. Officers: President, I. F. Wortendyke, Janesville, Wis.; Secretary-Treasurer, Henry Harmon, Milwaukee, Wis.